AVIATION

Volume 44

January-June 1945

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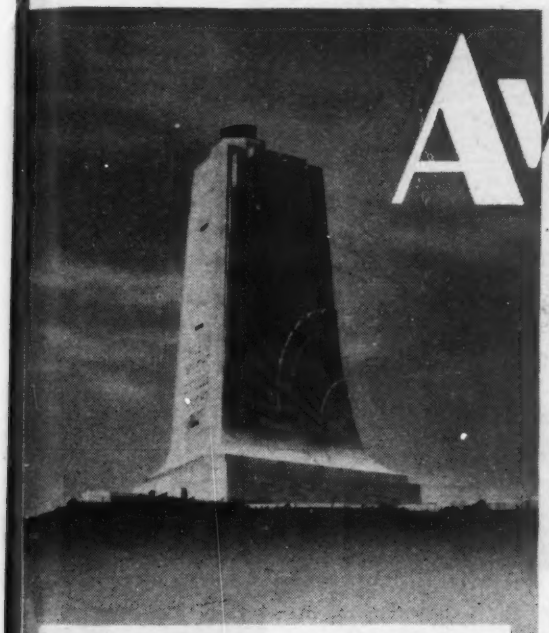

AVIATION

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Aviation is indexed in Guide to Periodical Literature and in Industrial Arts Index.

Pneumatic power—Boeing's answer for F-A-S-T operation of the bomb bay doors on the Supe fortress—now can be revealed. And Pacific Division also can announce that the air bottle us in the B-29 system together with the four cylinders that actuate the doors are Altair produc Both air bottle and cylinders are modifications of standard Pacific Division hydraulic units, whi are in use in virtually every U. S. military airplane.

In developing this new-to-aviation medium, Boeing engineers have perfected a lightweight super-fast method of actuation and Pacific Division is proud of its part in this pioneering work. Pacific Division, Bendix Aviation Corporation, 11620 Sherman Way, North Hollywood, California. Sales Engineering Offices, New York and St. Louis.

Photograph Courtesy Boeing Aircraft Co.
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Pacific Division
BENDIX AVIATION CORPORATION

11620 SHERMAN WAY, NORTH HOLLYWOOD, CALIFORN

ALTAIR PRODUCTS...PACEMAKERS IN AVIATIO

Briefing for January

Boeing B-17 Flying Fortresses have so consistently done things in combat that airplanes weren't supposed to be able to do that the B-17 has already become a legend in every war theater. And it's not hard to understand when you read the 10th in our Design Analysis series as written by Wellwood Beall, Boeing's vice-president in charge of engineering. Illustrated in AVIATION's unmatched style, it's a solid 24-pager, beginning on page 121.

Ray Hoadley, our financial expert, comes up with another triple-interest job this month—an article of special interest to manufacturers of all sizes of aircraft, to investors, and to all those who look afield for postwar distributing spots. Mr. Hoadley goes into the foreign trade question, telling just why the export markets are so vital. Page 118.

Speaking of marketing, just how important is this business of giving real service on accessories, replacements, and materials? On page 119, Jim Wales gages the values of such services and outlines the attendant problems, pointing out the dangers of being "Plane Wise and Part Foolish."

"So You're Going to Buy a Used Airplane" huh? Well, mister, there are plenty of things to look for, and on page 193 "Al" Lindsley tells you just what they are and shows you how to find them. It's a feature as valuable to those who want to be successful in *selling* planes as it is to prospective buyers.

Once the plane's bought, it's got to be maintained properly. And that, of course, calls for proper lubrication. So we're starting (page 195) a series of lubrication charts covering personal planes. These charts are all set up to be cut out—for putting in your plane-check folder or for pasting up on the shop bulletin board where they'll always be accessible.

We at AVIATION have manpower shortage troubles, too, and once in a while they crop out. In Ernest G. Stout's article in September, graphs in Fig. 20 and 21 should appear, respectively, over captions 15 and 16, and vice versa; also the curves of Fig. 20 and 21 (as printed) should be transposed. We'd have made this correction a lot sooner, but Ernie's been flying all over the South Pacific on an important mission and just called it to our attention.

KENNETH R. JACKMAN, chief engineer of Consolidated Vultee's Engineering Test Laboratories, isn't one of those researchers who stays buried in labs—he really gets around in connection with his work. His travels have shown that there's a dearth of material on workable research setups in the aircraft field, so he has done something about it. Starting this month—on page 115—he inaugurates an outstanding series on aircraft research and development that will be invaluable to everyone connected with the conception and production of finer American aircraft, for the series will not only analyze what needs to be done, but also the means for doing it.

E. E. WILSON not only has found time to serve as president of the Aero Chamber and as vice-chairman of United Aircraft, but he's also somehow found time to write—for publication soon—what we think will prove a mighty important book in reflecting his long and varied experience both in naval service and in industry. This month (page 112) we're proud to present a chapter from it, one which clearly shows how the airplane can influence the course of world history. And next month we'll publish another key chapter, one setting forth an air power policy under which the airplane can be used to maintain peace and prosperity instead of an instrument of destruction.

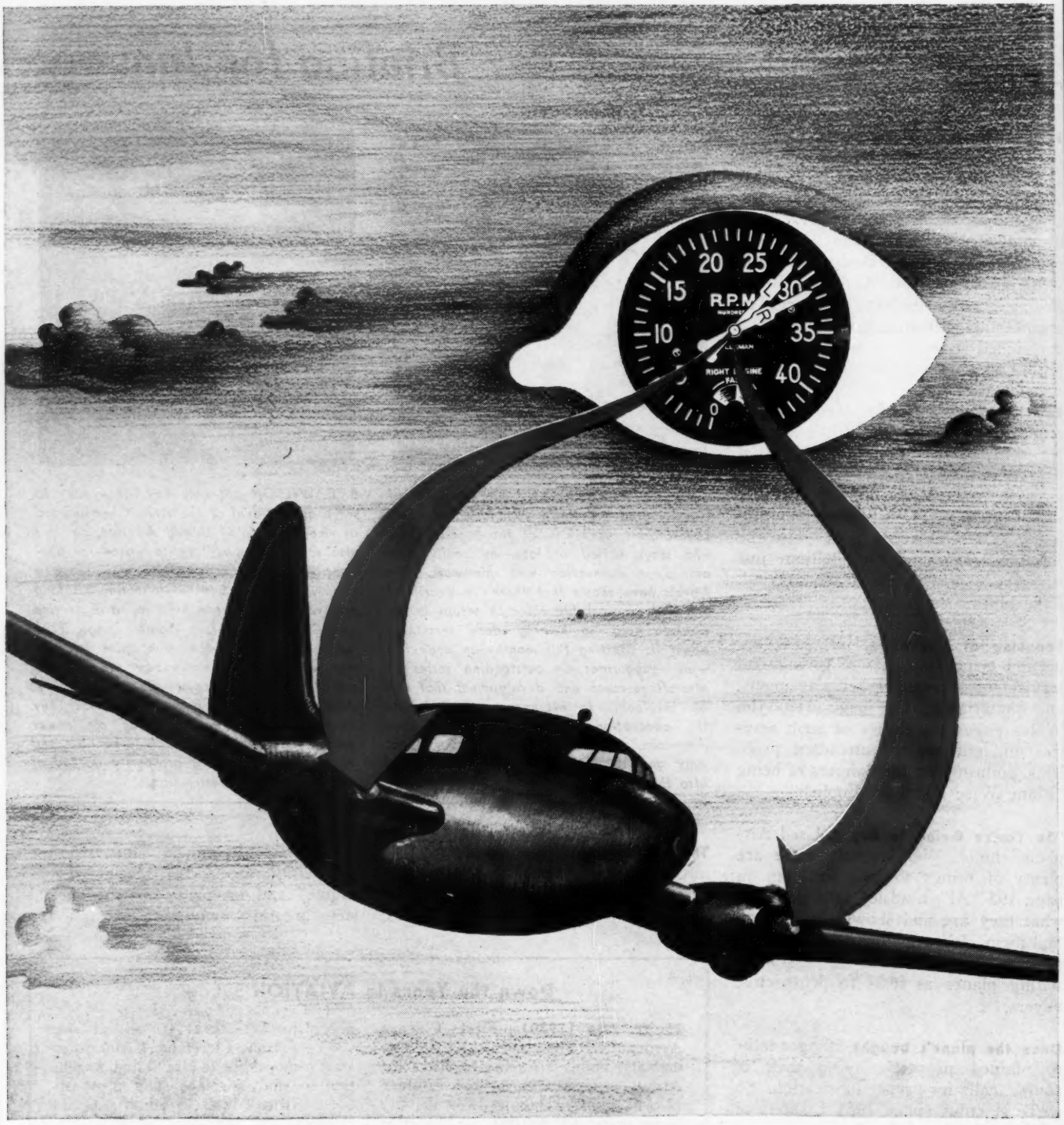
Three important conditions inherent in aircraft engine operation put heavy demands on the valves, which means that they have become, over the years, uniquely built units. Thus, "Valve Servicing Demands Special Technique," and on page 157 the special steps are fully detailed.

Down the Years in AVIATION'S Log

25 Yr. Ago (1920)—First Chicago Aeronautical Show opens . . . Westinghouse builds Micarta propellers for Army . . . Fiat turns out 720-hp./12-cyl. engine weighing 1,739 lb. . . Navy gets $27,000,000 for aviation construction and development . . . Dirigible hangar 804 by 318 ft. projected by Navy at Lakehurst, N. J. . . . Goodyear builds 95-ft.-long Pony Blimp.

15 Yr. Ago (1930)—PAA plans direct Miami-Cristobal service using 4-engine Sikorsky amphibians . . . Transcontinental air service inaugurated from Perth to Sydney, Australia . . . NYC Police get Keystone-Loening and Savoia-Marchetti amphibians. . . . Army orders 71 Thomas-Morse combat and observation planes . . . Six USSR aeronautical engineers arrive to study US airlines. . . . Cheyenne, Wyo., abolishes landing fees at city airport . . . Airmen in flight phone to *Leviathan* 700 mi. at sea. . . . Three Cleveland businessmen start 6-mo. flight to Brazil and Argentina to study airplane sales prospects . . . Airmail rates to South America reduced . . . Imperial Airways surveys London-Cape Town air route . . . French aircraft combine organized with $15,720,000 capital . . . USSR has 20,000 mi. of airways in operation . . . J. Corsin, French pilot, reported to have logged 625,000 flight miles in 12 yr. without accident.

10 Yr. Ago (1935)—Wall St. and 23rd. St. Skyports opened in New York . . . Martin builds 3,000-mi. range Clipper weighing 23,000 lb. empty, 51,000 lb. gross . . . Airlines speeding up service with Boeing 247's and DC-2's . . . Pacific Alaska Airways, now flying 20,000 mi. monthly, announces a 675-mi. route to Whitehorse and Juneau . . . Dutch KLM orders 14 DC-2's.



FOR TWIN-ENGINED AIRCRAFT, a new weight-saving, space-saving three-in-one instrument is available in the Kollsman Combination Dual Tachometer and Synchroscope. Indication of the speed of both engines is given on the dial of one instrument. Quick synchronism is obtained by simply matching pointers and then adjusting the throttle until the synchroscope dial is motionless.

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

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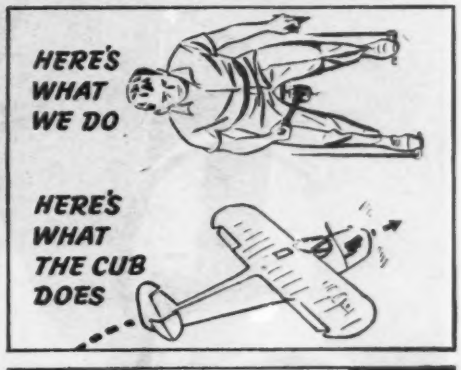
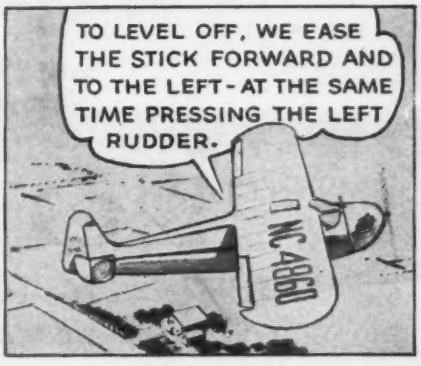
ELMHURST, NEW YORK • GLENDALE, CALIFORNIA





PIPER "PLANE QUIZ"

1. Can you buy a Piper Cub on the installment plan, after the war?
Yes, in much the same way as an automobile.

2. Is it easy to learn to fly a Piper Cub?
Yes, children of 8 and men of 70 have mastered it.

3. What is the cost of gas and oil in Piper Cub operation?
About one and one-third cents a mile.

4. How carefully is the Piper Cub built?
To the same rigid government specifications as the largest airliner.

This lesson and others that will follow explain only the fundamentals. See your Piper Cub dealer for actual flying instruction. Write us "Plane Quiz" questions you want answered.

PIPER AIRCRAFT CORPORATION — LOCK HAVEN, PENNA.
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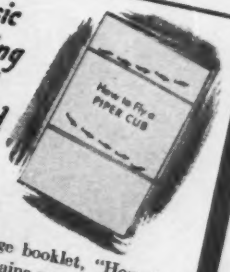
PIPER CUB

Points the Way to Wings for ALL Americans

All the Basic Steps in Flying are Pictured and Described in This Booklet

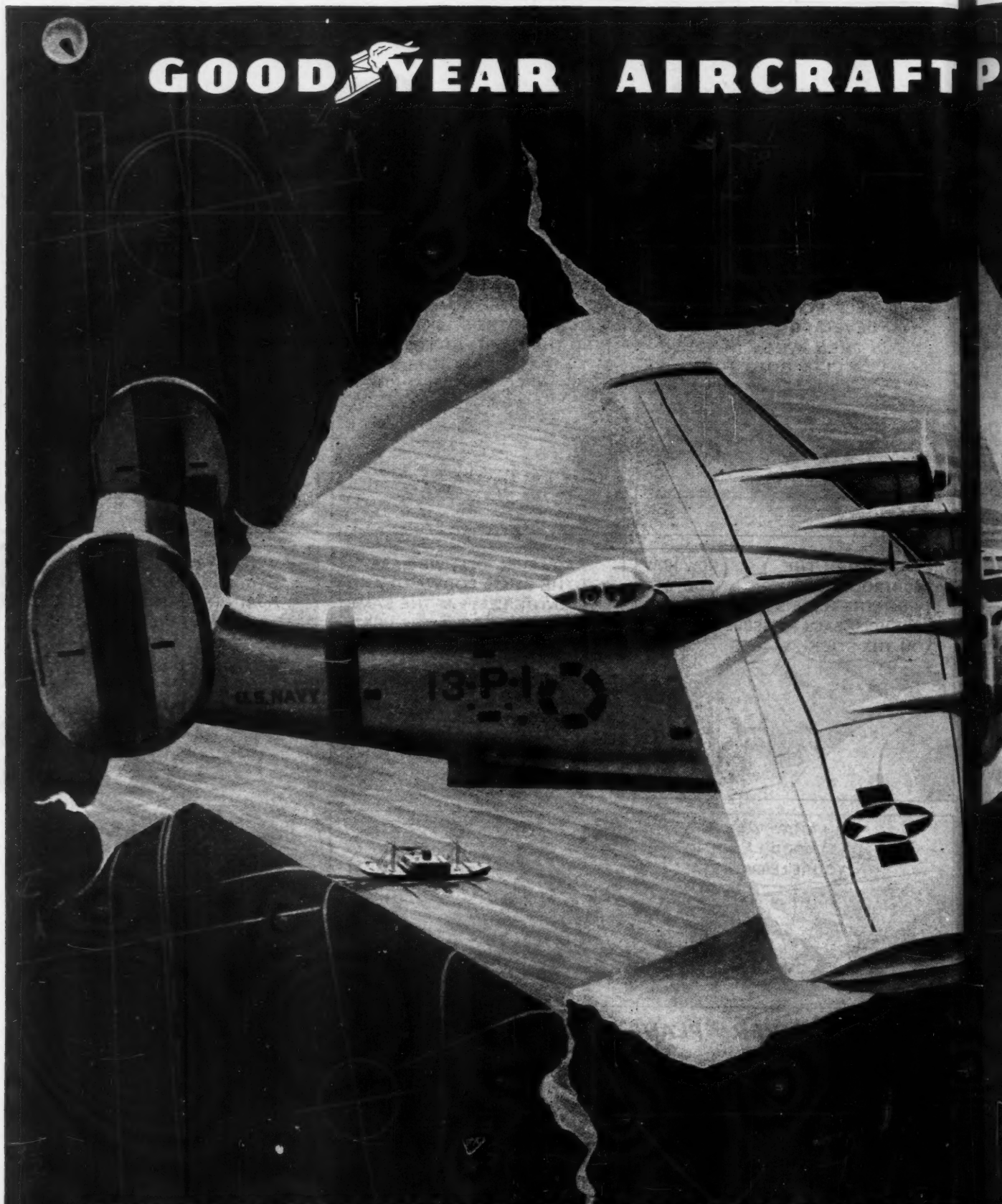


Attractive new 32-page booklet, "How to Fly a Piper Cub," contains over 50 step-by-step photos and descriptions of an actual flight lesson. Plus other interesting flight information, full-color pictures of new Piper Cubs. Get yours now! Send 10c in stamps or coin for postage-handling. Write Piper Aircraft Corporation, Dept. A15, Lock Haven, Pennsylvania.

IS YOUR TOWN READY TO FLY? It should plan landing facilities now—for its citizens and its future. The booklet, "What Your Town Needs for the Coming Air Age," illustrates various types. It covers benefits, where to build and how to start. For your free copy, write Piper Aircraft Corporation, Dept. A15W, Lock Haven, Pennsylvania.

16 mm. SOUND FILM—"The Construction of a Light Airplane." For distribution points write: Supervisor, Audio-Visual Aids, Extension Services, Penna. State College, State College, Penna.

GOODYEAR AIRCRAFT P



HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE

1. By constructing major components to manufacturers' specifications.

2. By designing parts for all types of airplanes.

3. By re-engineering parts for quantity production.

4. By building complete airplanes and airships.

FT PRODUCTION REPORT

CONTRACTS: 78903, 85402, 97126

CONSOLIDATED PB2Y3
(Coronado)

FLIGHT DECKS, AILERONS, ELEVATORS, RUDDERS, STABILIZERS, FINS, FLAPS, OUTER WINGS AND FLOATS FOR 250 PLANES

FIRST CONTRACT RECEIVED: *DECEMBER 1940*

FIRST PRODUCTION UNIT DELIVERED: *JANUARY 1942*

CONTRACTS COMPLETED: *MAY 1944*

Goodyear Aircraft's part in making possible the quantity production of these huge four-engined Navy Patrol Bombers (115' wingspread, 79' length) included the complete re-engineering for production of all above-named assemblies except flight deck. Once re-engineered, Goodyear's ingenuity made it possible for these major components to be produced on time. Record of these big flying boats in the Pacific testifies to the success of Goodyear's share of light metal engineering in solving the complex production and engineering problems.

Goodyear is building components for 16 different Army-Navy types of aircraft, including complete Corsair fighters and Navy airships.

AIRCRAFT INDUSTRY

5. By extending facilities of Goodyear Research Laboratories to aid the solution of any design or engineering problem.

GOODYEAR AIRCRAFT

GOODYEAR AIRCRAFT CORPORATION
Akron, Ohio • Litchfield Park, Arizona

YES, to all the other standout advantages of Goodyear's sensational new Single Disc Airplane Brake, you can now add complete automatic adjustment. This is accomplished by means of an ingenious new self-compensating mechanism within the brake that automatically "takes up" wear in the lining, giving you uniform braking action at all times.

The result is a brake that always operates at maximum efficiency. It requires no initial adjustment, no "wearing in." Pedal "feel" is always the same — you don't have to push down harder and farther as brake linings wear thin. When linings eventually need replacement, *it is only a few minutes' job for both brakes!*

And because of its extreme simplicity, this new Goodyear development provides the lightest-weight brake-wheel unit per foot-pound of energy capacity. It's a brake that doesn't overheat tires and tubes — the braking disc is "washed" by the slip stream for continuous cooling.

These are just a few of the reasons why the Goodyear Single Disc Brake is now being specified for all types of ships from light trainers to heavy superbombers. It's made in both hydraulic and mechanical types. Write for complete specifications to Goodyear, Aeronautics Department, Akron 16, Ohio or Los Angeles 54, California.

THE TIRE IS THE GOODYEAR ICE-GRIP

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GOODYEAR RESEARCH LABORATORY RUBBER SCIENCE HEADQUARTERS

YEAR AVIATION PRODUCTS

Ice-Grip, Griptred, Chemigum, Airfoam, Pliofilm, Plioform, Pliofoam, Isoprene
—T. M.'s The Goodyear Tire & Rubber Company

RUBBER

You Get Corrosion Resistance *Plus* EASY, ECONOMICAL FABRICATION with Carpenter Stainless

When you consider putting new zest, greater "eye" appeal into your new or redesigned products—when you consider giving them greater strength and a higher factor of safety—when you consider endowing them with special physicals to meet unusual service conditions—the first thing that comes to mind is "Let's make it from Stainless."

But beyond these immediate sales and utility advantages, you want Stainless Steels that will work with you right from the start.

Easy-working Carpenter Stainless Steels for instance, can help your shop get into production faster. Because they form easily, blank cleanly and permit faster press and machining speeds, they smooth the way from drawing board to finished product. In addition, these Stainless Steels save time and expense in the finishing room.

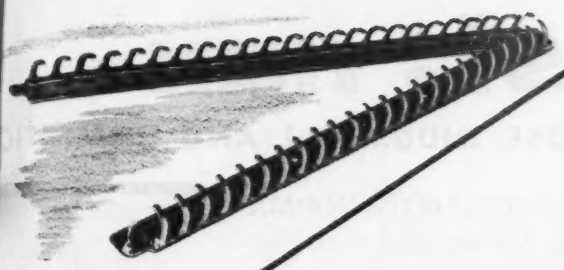
Carpenter has spared neither time nor expense to bring you the easiest fabricating Stainless Steels that ever hit your production line. The same group of Stainless experts who helped make possible ductile, easy-working Stainless Strip and Free-Machining Stainless bar stock are ready to apply their experience to your problems. Let them help you select the proper Stainless for the job. Let them help you cut corners and costs in your fabricating shop.

Call in your nearby Carpenter representative now, or write us at the mill. And if you do not already have a copy, send for our 98-page book, "Working Data for Carpenter Stainless Steels." A note on your company letterhead, indicating your title, is all that is necessary.

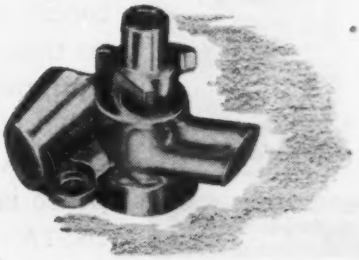
Give Your Products These Advantages

- Sales Appeal
- Everlasting Beauty
- Freedom from Rust
- No Plating to Peel
- Weight Saving
- Strength and Rigidity
- Ease of Assembly
- Fewer Service Complaints

more than corrosion resistance

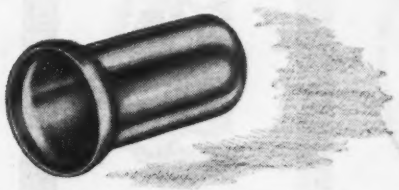


SAME DIES as were previously used to form and blank ordinary cold rolled strip, later made this ingenious Stainless loose leaf binder. Ductile, uniform Carpenter Stainless #6 assured clean stamping, easy crimping, smooth bends. In addition, this satin-finish Stainless eliminated all polishing operations.

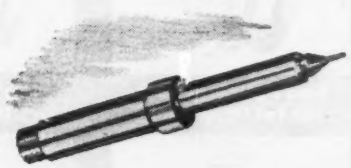


LOWER UNIT COSTS This aircraft fuel supply valve body was forged from Carpenter Stainless #8 forging bars. Our *machine-turned* billets from which all Carpenter Stainless forging bars are rolled, assure freedom from surface defects. The result: sound, flawless forgings for you, with minimum rejects.

PERMANENT "EYE" APPEAL When manufacturers of equipment like fishing reels want to give their products lasting beauty that never peels off, or becomes marred by rust, their natural choice is Stainless. And when the job combines forming, stamping and machining operations, they find Carpenter Stainless Steels save time and expense through every step of fabrication.



NO PROCESS ANNEALING Ordinarily a difficult deep-drawing job like this could cause plenty of headaches and expense. But with Carpenter Stainless #6 the cups were easily deep drawn and without process annealing. Do any parts for your postwar products involve deep-drawing? If they do, investigate easy drawing Carpenter Stainless Strip.



AUTOMATICS USED This airplane part, machined in automatics from Carpenter Stainless #8 bar stock, indicates what can be done with Free-Machining 18-8 Stainless.

THE CARPENTER STEEL COMPANY, 128 W. BERN ST., READING, PA.

Carpenter STAINLESS STEELS

BRANCHES AT Chicago, Cleveland, Detroit, Hartford, St. Louis, Indianapolis, New York, Philadelphia

VICTORY, first: THEN—

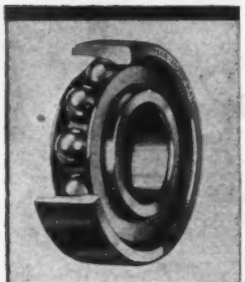
PRECISION BEARINGS FOR EVERY PURPOSE, INDUSTRIAL AND DOMESTIC

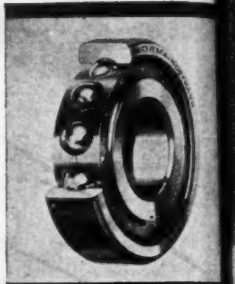
War's demands still call for all the output of the NORMA-HOFFMANN factory. But, already, far-sighted manufacturers are working with NORMA-HOFFMANN engineers on their designs for new and better peace-time products equipped with PRECISION BEARINGS.

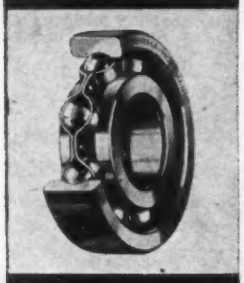
No "Re-conversion Problem" will hamper or delay NORMA-HOFFMANN post-war production. The moment peace is declared, all our vast facilities will be turned INSTANTLY to the production and prompt delivery of PRECISION BEARINGS for new and better domestic appliances and for new and better tools for industry.

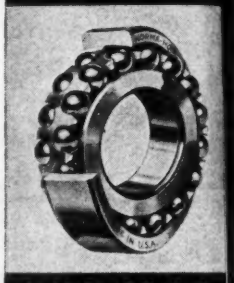
Our Field Engineers, in all our District Offices, are ready to work with YOUR designers. Avail yourself of their experienced counsel NOW—without obligation, and of course in strict confidence. *Write for the Catalog—Today.*

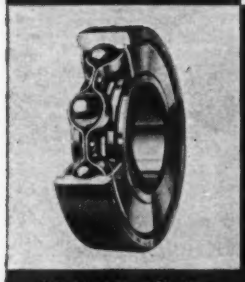
TO WIN THE WAR: WORK—FIGHT—BUY WAR SAVINGS BONDS!

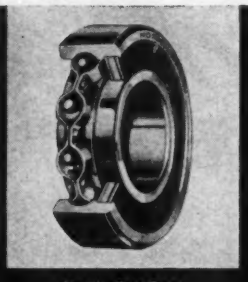

Separable (Magneto) Ball Bearing

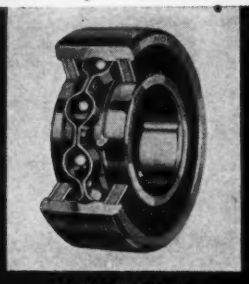

Litro ("CL") Composition Retainer Ball Bearing

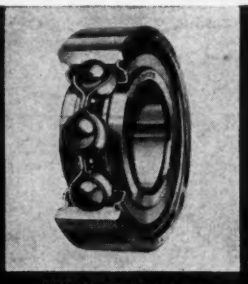

Single Row Ball Bearing

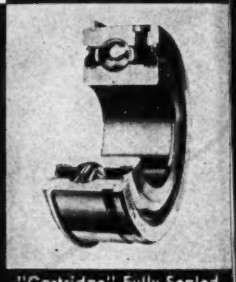

Double Row Self-Aligning Ball Bearing

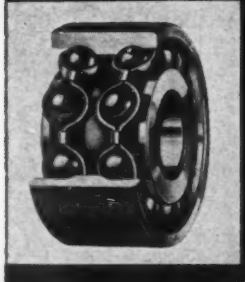

Shielded Type Single Row Ball Bearing

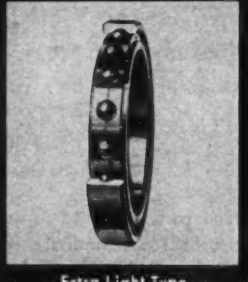

Single Felt Seal Ball Bearing

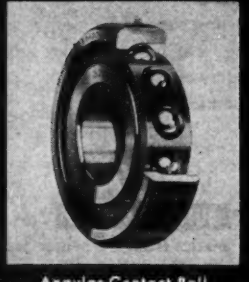

Double Felt Seal Ball Bearing

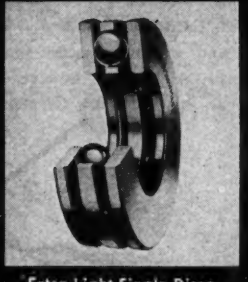

9000 Series (Feltless) Sealed Ball Bearing

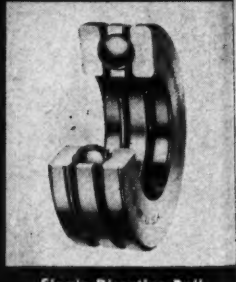

"Cartridge" Fully Sealed, Refillable Type Ball Bearing

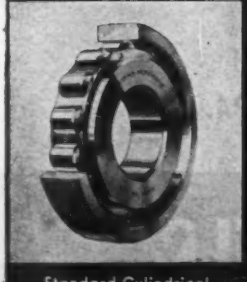

Double Row Ball Bearing

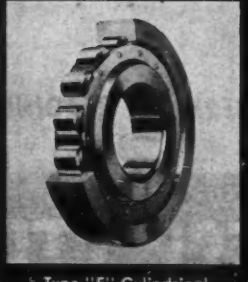

Extra Light Type Ball Bearing

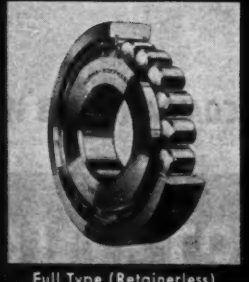

Angular Contact Ball Bearing


Extra Light Single Direction Ball Thrust Bearing

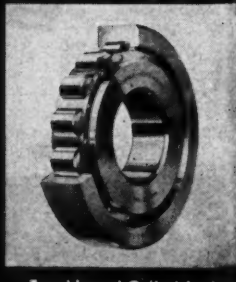

Single Direction Ball Thrust Bearing


Standard Cylindrical Roller Bearing


Type "E" Cylindrical Roller Bearing


Full Type (Retainerless) Cylindrical Roller Bearing

Extra Light Cylindrical Roller Bearing


Two-Lipped Cylindrical Roller Bearing

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SCRAPPY FLOAT PLANE DOWNS JAP ZERO

IN a recent engagement against Japoccupied *Iwo Jima*, a KINGFISHER Observation Scout Seaplane (OS2U) had been catapulted off a United States cruiser to direct Naval gunfire.

Circling over the island in full view of an enemy airfield, Lieutenant Robert W. Hendershott, U.S.N.R., of Bend, Oregon, pilot of the lightly armed little float plane, calmly proceeded to fulfill his hazardous but vitally important mission.

The slow-cruising Kingfisher looked like an easy mark to the Nip's nest of Zero fighters. Hardly had the surface vessels begun their bombardment, when Hendershott's Observer, Arthur E. Hickman, Aviation Radioman, second class, U.S.N.R., of Denver, Colorado, spotted three Zeros spiralling up.

Rapidly gaining altitude, the enemy planes opened fire on the Kingfisher from below. The lead attacker made a stern approach. Hickman, crouching over his light machine gun, coolly bided his time, and as the fast, heavily armed Zero came within range, let go with a perfectly aimed burst into its engine.

Hickman's bullets must have killed the Jap pilot. For the Zero roared on in—sheared off the Kingfisher's starboard wing tip—and crashed into the sea.

The second Zero came on. Its bullets ripped through the Kingfisher's fuselage within inches of the Navy pilot's legs. The oil tank was punctured. Hot oil spurted over the windshield and cockpit.

Again and again, the two fast and highly maneuverable Jap fighters slammed at the crippled Kingfisher. The fuselage was completely riddled. Finally, Pilot Hendershott maneuvered his plane within reach of the protecting screen of U. S. destroyers and cruisers—and the Jap fliers pulled away!

Score: One Edo float equipped Navy Seaplane damaged. One latest-type Zero knocked into the sea. Two other Zeros badly baffled by a non-combatant observation plane manned by two very combat-minded Navy men. The Japs should file a complaint!

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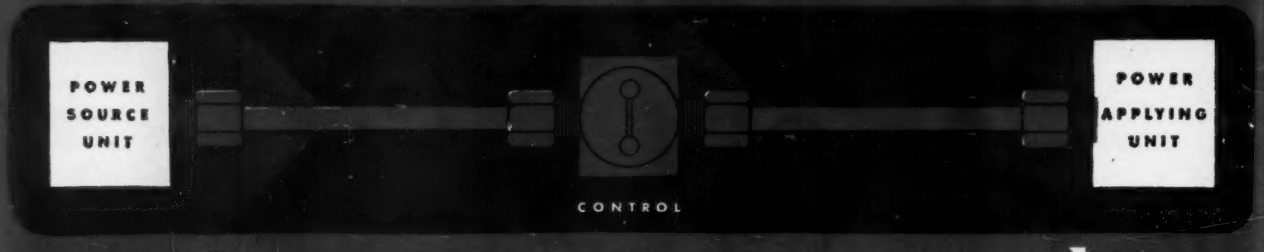

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The Circuit carries fluid power around corners and into tight places—wherever you want it to go. It must be leakproof, vibration-proof, able to stand high pressures and resist corrosion.

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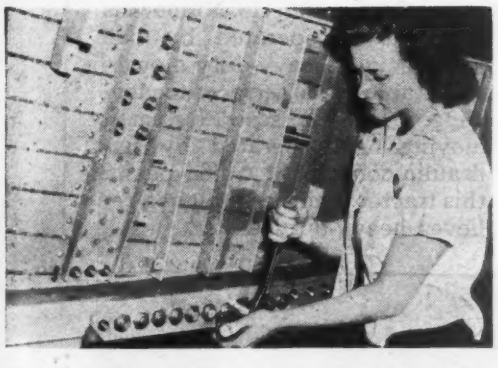
a beautiful picture of "MILLIONS OF FASTENERS"



Photograph shows National Screw AN hex head and NAS close tolerance bolts being used in fabrication of a main structure of the Boeing B-29 Superfortress.

A sizable segment of American industry shares in the production of the Boeing B-29. Like the old fable of the blind men and the elephant, the Superfortress means many things to many people. To us at National Screw it means the last word in fasteners.

Throughout this giant plane, both in the airplane proper and in the instruments and armament, *National* screws, bolts, nuts, studs, rivets, cotters and many special fasteners are used by the thousands.

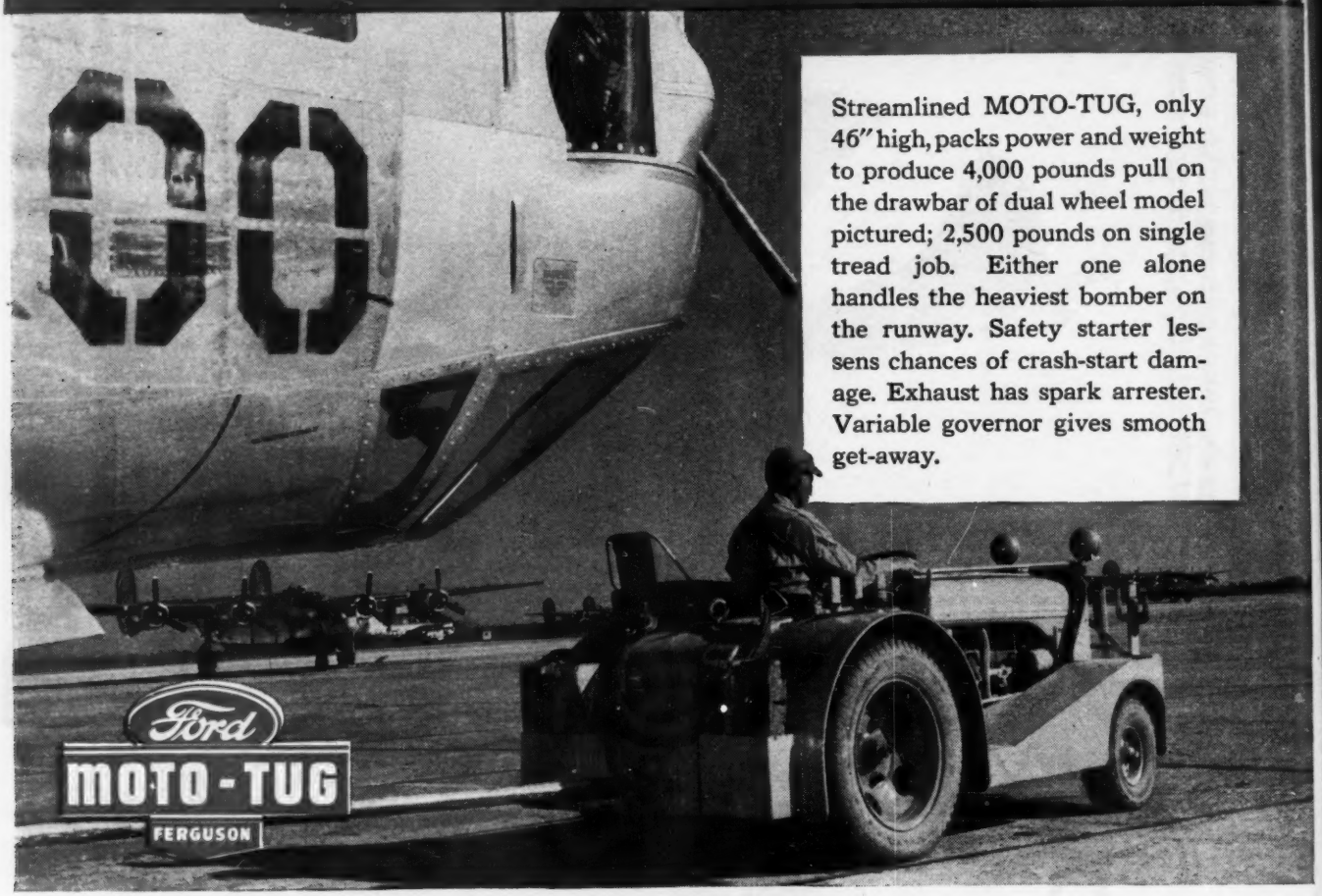
Following are a few of the *National* fasteners in the B-29:

NAS and BAC close tolerance bolts.
NAS internal wrenching bolts.
BAC bearing bolts.
AN bolts, nuts and screws—complete line.
Carburetor Studs.
Instrument Screws.

National HEADED AND THREADED PRODUCTS

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.

POWER FOR GROUND CREWS..
As advanced as tomorrow's planes



Streamlined MOTO-TUG, only 46" high, packs power and weight to produce 4,000 pounds pull on the drawbar of dual wheel model pictured; 2,500 pounds on single tread job. Either one alone handles the heaviest bomber on the runway. Safety starter lessens chances of crash-start damage. Exhaust has spark arrester. Variable governor gives smooth get-away.

Ford Tractor
FERGUSON SYSTEM

Sweeping snow from runways and apron is only one job the versatile Ford Tractor with Ferguson System can do. Numerous attachments, operated by one man, include heavy-duty mower, adjustable blade terracer for leveling, loader and scoop for earth moving. All operated by hydraulic control. At traffic peaks, this tractor hauls light planes, relieves heavy-duty units.

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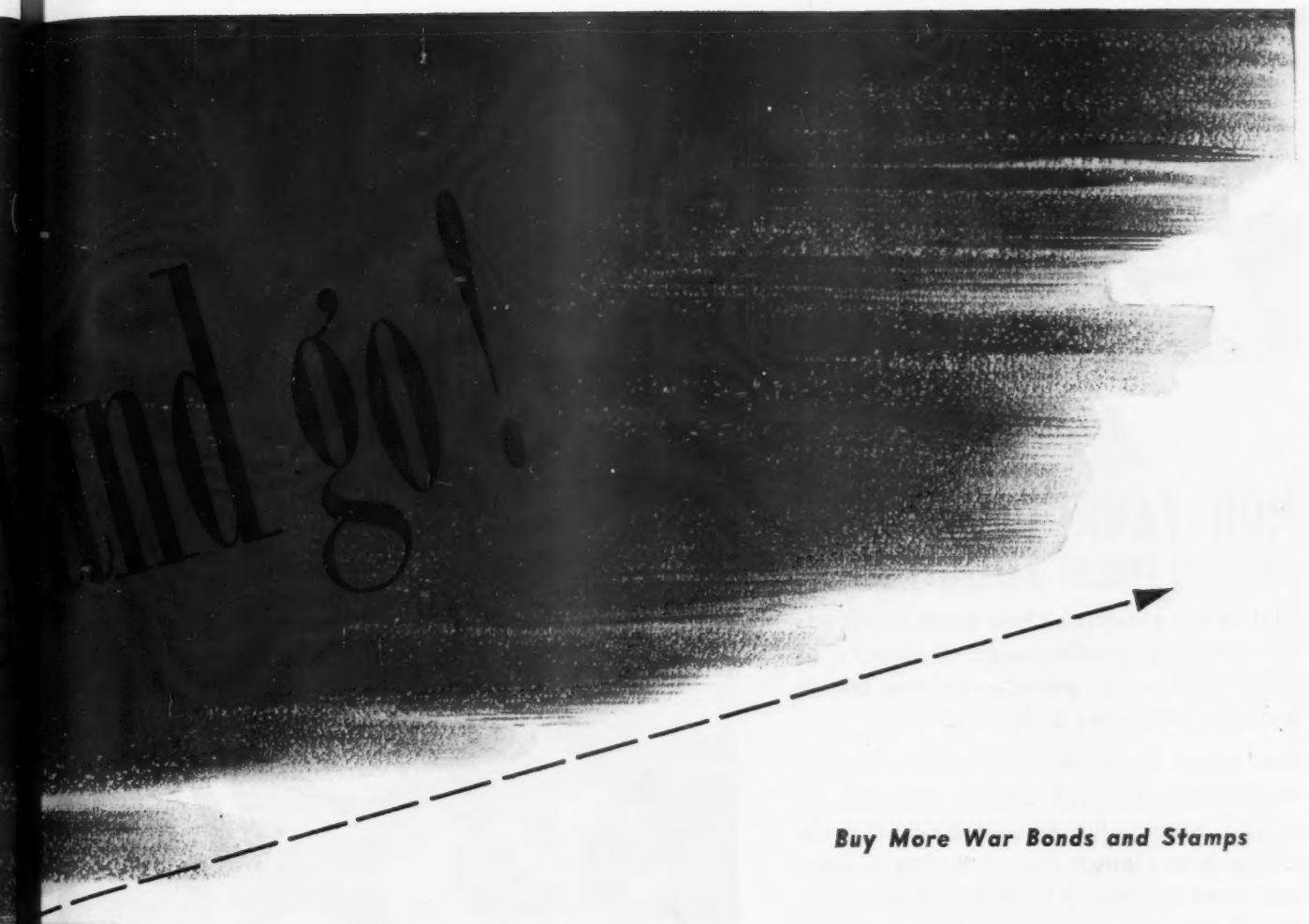

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"Enemy aircraft approaching!" . . . and it's *touch and go* for the flattop fighters! Out where a delay of seconds could sink the ship, Jack & Heintz starters are famous for sure-fire performance. And wherever *touch* and *go* starting is vital . . . in arctic cold or tropic heat or desert sands . . . these starters are pitting terrific stamina against the toughest battle conditions.

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So valuable in war, this ability . . . these methods hold great new things in store for peacetime aviation. Watch for the fulfillment of their promise.

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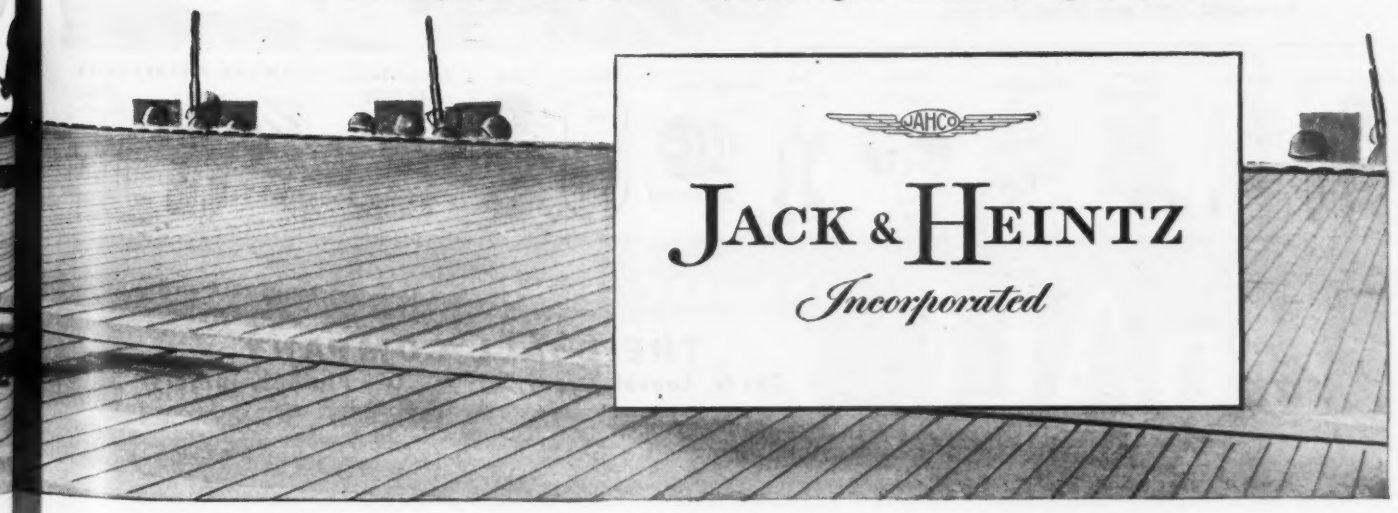

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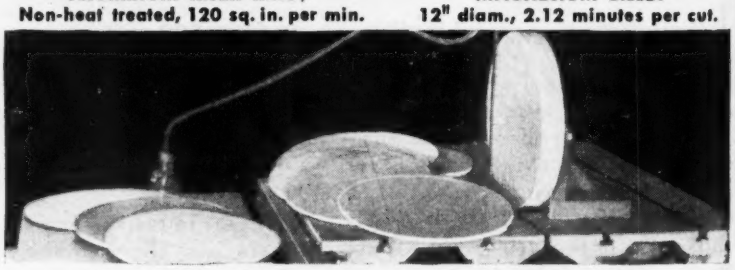

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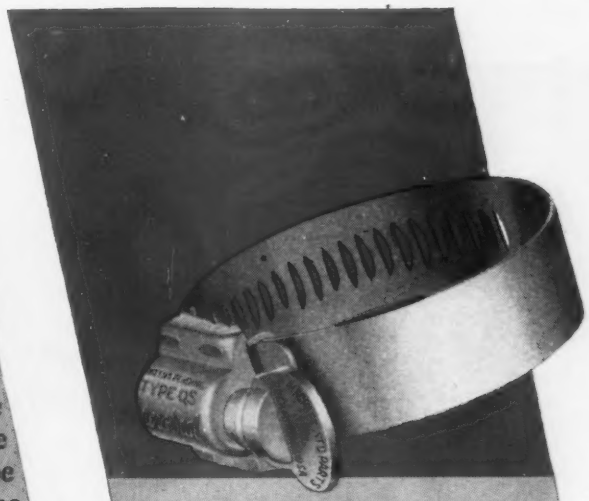
STAINLESS STEEL

Where service conditions require highest corrosion resistance, these *all-stainless-steel* clamps should be used. They incorporate all the basic superior features of AERO-SEAL design plus some distinctive engineering advantages such as *non-welded saddle*, greater strength, greater flexibility, and slightly less weight than their carbon steel counterparts. They will soon be available in all nominal sizes from ½" through 4¼". Let us know your needs *now*, so we can advise you as accurately as possible on the scheduling of future deliveries.



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Selected, heat-treated carbon steels, finished in high-grade cadmium plate for rust resistance, go into the making of these AERO-SEAL Hose Clamps. Millions of these clamps are in strenuous active service and have achieved the widest acceptance under the strict requirements of Army-Navy Specification AN-FF-C 406a. Manufacturing facilities for all sizes in the full range are now functioning adequately so that orders can be scheduled for near-future delivery or as needed. We urge that you advise us of your future requirements *now* so that we can take care of your needs as promptly as possible.

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- UNIFORM PERIPHERAL TIGHTENING
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- SELF-LOCKING, NO LOCK WIRE NEEDED
- CAN BE PUT ON HOSE IN PLACE
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Important Parts of the M-103 NOSE BOMB FUSE Are Made in Arnolt Plants

The precision bombing that has crippled Axis war production is the result, not only of superior bomb sights and better trained crews, but also of more carefully made bombs and bomb fuses. Arnolt is proud to be entrusted with the production of important parts of the famous M-103 bomb fuse which so accurately controls the timing of the explosion of general purpose, demolition, and S.A.P. bombs ranging in size from 100 to 4,000 pounds. Arnolt craftsmen are skilled in building precision parts of all types for prime contractors. For details regarding their qualifications to serve you, write for a copy of the interesting brochure, "Available Facilities for the War Program."

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LOOKING AHEAD

New ideas and new devices come thick and fast in wartime. America's manufacturers have worked tooth and nail with the Army and Navy to produce all the modern equipment the armed forces need.

Among these manufacturers is Lear. The Lear aircraft radio was well known long before the war. It was ready for the armed forces when war came. Then Lear explored new fields and produced the special Lear midget motors, the Fastop Clutch, and Lear Actuators which make it possible to move airplanes' flaps, shutters and landing gears accurately by electricity.

All Lear wartime developments couldn't be mentioned here. Many of them and the engineering ingenuity which produced them will be turned to peacetime conveniences and pleasures.

For example, there will be the new Lear home radios — instruments built with the integrity demanded by aircraft radio, and equipped with features unknown in such sets before.

So while everything keeps going to get wartimes over with, we can afford a look ahead to the bright spots in the peace we have been fighting for.

RADIO DIVISION, GRAND RAPIDS 2, MICHIGAN
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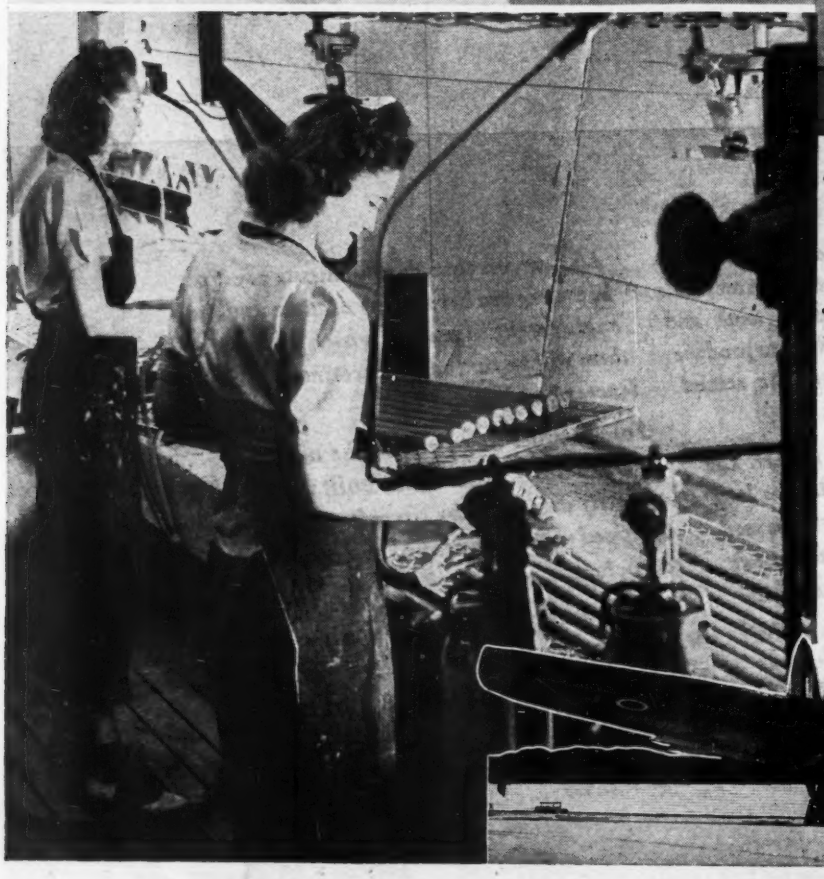


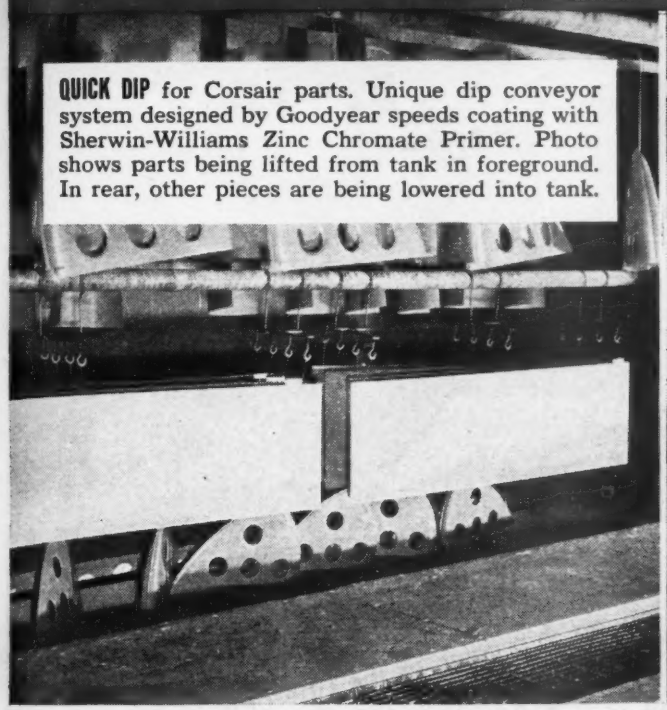
"DESTINATION UNKNOWN" — It's a Navy secret but these 3 Corsairs will get there faster. They're finished with Glossy Sea Blue Lacquer, which adds to their speed.

PROTECTIVE COAT of Sherwin-Williams Zinc Chromate Primer is sprayed on Corsair parts in spray booth at Goodyear Aircraft's plant in Akron, Ohio. Huge pressure tanks supply the paint guns.

READY AND ANXIOUS FOR ACTION. This new Corsair with its coat of Glossy Sea Blue Lacquer will soon be some British fighter pilot's pet Pegasus.

SHERWIN-WILLIAMS

FASTER FINISH!



QUICK DIP for Corsair parts. Unique dip conveyor system designed by Goodyear speeds coating with Sherwin-Williams Zinc Chromate Primer. Photo shows parts being lifted from tank in foreground. In rear, other pieces are being lowered into tank.

PRE-FLIGHT FINISH. Final coat of Glossy Sea Blue Lacquer is applied in spray booth holding completed ship. Like all spray booths at Goodyear, this one is equipped with forced ventilation through a back wall of water.

Corsairs by Goodyear get added speed from finish by SHERWIN-WILLIAMS

Goodyear Corsairs now being turned out for the Navy fly five knots faster than those originally produced. The increased speed is effected by the use of a new, supersmooth finish which cuts wind resistance to a minimum — Glossy Sea Blue Lacquer!

The new finish, developed under Navy supervision, eliminates tiny irregularities which would affect air flow and interfere with performance. Yet there's no loss of the toughness necessary to withstand extremes of temperature, corrosion of salt spray, or abrasion of sand. For protection against oxidation, nearly all parts are precoated with Sherwin-Williams Yellow Zinc Chromate Primer.

To Goodyear's speedlined, highly mechanized production methods, both Primer and Lacquer are admirably adapted for conveyorized dipping and spraying procedures and for both the quick-drying methods employed: heat lamps and forced hot air, or atmospheric evaporation accelerated by chemical dryers in the paint.

If *your* products call for finishes that combine serviceability with application economy, Sherwin-Williams is the name to remember! Write The Sherwin-Williams Co., Cleveland 1, Ohio.

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"IT HAPPENED OVER TIBET-"
The order to abandon ship came as the Liberator returned from her bomb run on Formosa. The flak got her bad . . . below lay wild and desolate Tibet. There was no choice but to bail out. Automatically they pulled their rip cords and just as automatically their parachutes opened. Nine men floated safely to earth and friendly natives led them back to their base.
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The Pioneer Parachute Company is proud of the role it has played in saving the lives of American airmen . . . in spearheading many paratroop actions . . . in delivering tons of supplies on every battlefront in this war. It is the kind of performance that will mean greater safety for the thousands of civilian flyers in the years after peace, because you can count on Pioneer Parachute Company to produce lighter, stronger, dependable parachutes for peacetime aviation.
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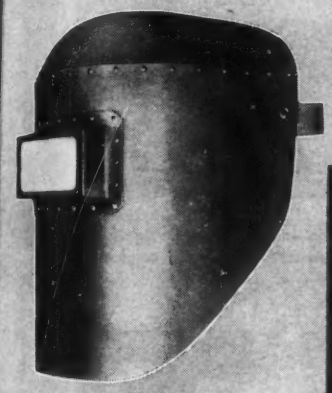
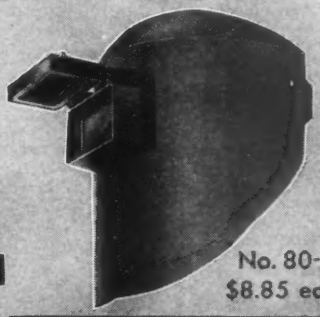
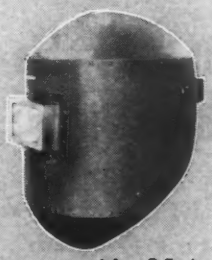


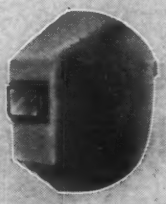
No. 45-A
$6.60 each*



No. 80-A
$8.85 each*



No. 25-A
$7.05 each*



No. 70
$3.40 each*

No. 66
$4.75 each*

These quality arc welding helmets afford a wide range of selection to meet individual preferences, as follows:

No. 45-A: Strong and leakproof, weighing only 15 oz. without lens. Made of best grade, non-warping, black vulcanized fibre. Adjustable chin rest, free-floating wide range headgear.

No. 80-A LIFT-FRONT HELMET: Same as No. 45-A, except that it has a lift-front glass holder. Operator may observe work without lifting helmet. Space is provided for extra clear glass. Weight, about 21 oz. without lens.

No. 25-A: Compact, form fitting, and well ventilated. Especially designed for close-quarter use. Made of best grade, non-warping, black vulcanized fibre. Adjustable chin rest, free floating wide range headgear. Weight, 16 oz. without lens.

No. 70: A lower-priced helmet that is serviceable, well-made, and leakproof. Made of good quality, non-warping, black vulcanized fibre. Adjustable headgear and chin rest. Weight, 14 oz. without lens.

No. 66: A moderately priced, leakproof helmet. Leather sweatband, sliding type adjustable headgear. Streamlined design makes it ideal in close quarters. Weight, about 19 oz. without lens.

**Prices do not include colored plate and cover plate. Prices given above are subject to discount in lots of 12 or more.*

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This handy booklet gives prices, sizes and shipping details on Airco's comprehensive line of gas and arc welding accessories. Mail the coupon for your free copy. If you also want facts on Airco Electrodes, indicate request on the coupon.

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HERE'S WHAT YOU CALL A REALLY GOOD IDEA

. . . and you ought to be able to think of one just as good!

THE LAPOINTE SHOCK RING JIMMY came to us without a name. It was merely an idea about how to meet a great need in servicing two popular makes of light planes. From its first crude form, we developed it into a handy, foolproof tool. Today it is in enormous demand.

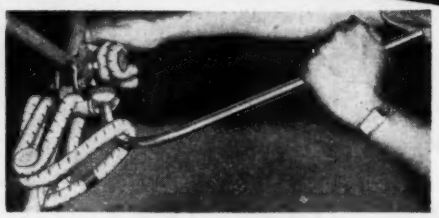
Now we'd like to turn our engineering and production skills to other servicing problems. You can help us do this . . . and earn money for yourself.

HERE'S ALL YOU HAVE TO DO

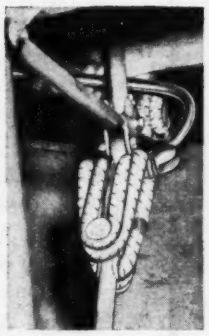
Think of some servicing problem like shock ring installation, that should be answered by some new device. Write us a letter, describing the problem. If we can solve it, and put our solution into production, we will send you a $500 check for telling us about the problem. (Of course, the first person to suggest the problem will be the only one considered on any single matter.)

Better yet, if you yourself have devised, or can devise some method of meeting a servicing problem, let us know what it is. If we decide to develop your idea and put it into production, we will make arrangements with you on either an outright purchase or royalty basis — as we have done with the man who suggested the Jimmy. (He gets a set figure for every Shock Ring Jimmy sold.)

Give complete details, such as the make and model of ship you are writing about. Include rough sketches, if possible. Why not sit down tonight, remembering all the servicing difficulties you've ever experienced, and write us that letter?!



HOW IT WORKS. Slip end of LaPointe Jimmy handle through shock ring, drop Jimmy's swivel head in place, then push or pull handle up and over.



WHAT HAPPENS. Shock ring easily slides down handle and over head, without cutting or fraying. Ring is on without twist. Jimmy pops off, ready for next job.

CLEARS TAYLORCRAFT dash. Other photos show Jimmy in use on Piper Cub. This shows how Jimmy works as easily and quickly on Taylorcraft.

THESE ARE DISTRIBUTORS OF THE JIMMY:

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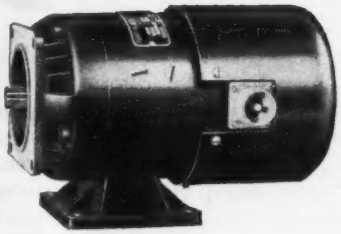

EMERSON-ELECTRIC AIRCRAFT MOTORS are made for gun-turret drives, hydraulic units, fuel pumps, actuators, winterizing units, communication systems—also with built-in gear and magnetic brake.

The armature of an Emerson-Electric Aircraft Motor on test has no privacy. Revolving in the coldly scientific beam of a high-frequency lamp it has no chance to conceal an unbalanced condition. If one does exist, the meter registers it instantly and it is corrected.

This inspection is but one of many which combine to insure production of electric motors which maintain the quality and performance standards associated with the name Emerson-Electric for 54 years.

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EMERSON ELECTRIC

MOTORS · FANS — APPLIANCES

BUILDING VERTICAL SKYWAYS

By WAYNE W. PARRISH

Publisher of "American Aviation" tells of Bell Aircraft's progress in helicopter development

"IN my estimation it will be some time before flying around the country in a helicopter becomes widespread. However, great strides are being made in the development of rotary wing aircraft. One outstanding achievement is Bell Aircraft's new helicopter which, largely through *two* ingenious innovations, has made possible both stability and precision control.

"One innovation is a two-bladed rotor, supported on a universal joint so that it is free to 'see saw' and at the same time to turn on its longitudinal axis. The second is a bar which, gyroscopically, tends to keep the rotor in its plane of rotation regardless of the position of the mast. This is a basic Bell Aircraft patent which works for stability under all conditions. It is found only in the Bell helicopter.

"The Bell helicopter represents a type of aircraft men have long wanted. It can take off and land on a very small plot of ground, and even in winds of nearly gale force it can fly up, down, backwards, forwards and sidewise—and still remain stable and under perfect control.

"When ceiling and visibility are too poor for a fixed wing plane to fly—then it's 'helicopter weather'—for the helicopter can slowly, safely feel its way through murk or fog.

"The helicopter will have many important industrial uses in the postwar world. Plans are already being formulated for its use in crop dusting, forest fire patrol, pipe line patrol, emergency rescue work, feeder taxis for airlines, executive travel, and many other peacetime applications.

"When this progressive company can turn its skills and resources to producing peace-time needs, look to the Bell helicopter to be one of the leaders in the postwar aviation field."

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Airacomet—America's First Jet Propelled Plane
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as original equipment

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GREASE FITTINGS
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Lincoln Kleenseal Fittings are available in all sizes and styles to meet every modern requirement. They are listed below and on the following pages by thread sizes and types. All fittings have spring and ball check unless otherwise stated.
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OVERALL LENGTH
No. 5005
OVERALL LENGTH
No. 5503
OVERALL LENGTH
No. 5575
OVERALL LENGTH
(Water Pump)
(No. 5560 Cap Only)
LINCOLN KLEENSEAL
PIPE THREAD ELBOW (Continued)
No. 5400
OVERALL LENGTH
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Consult LINCOLN on all of your grease fitting requirements

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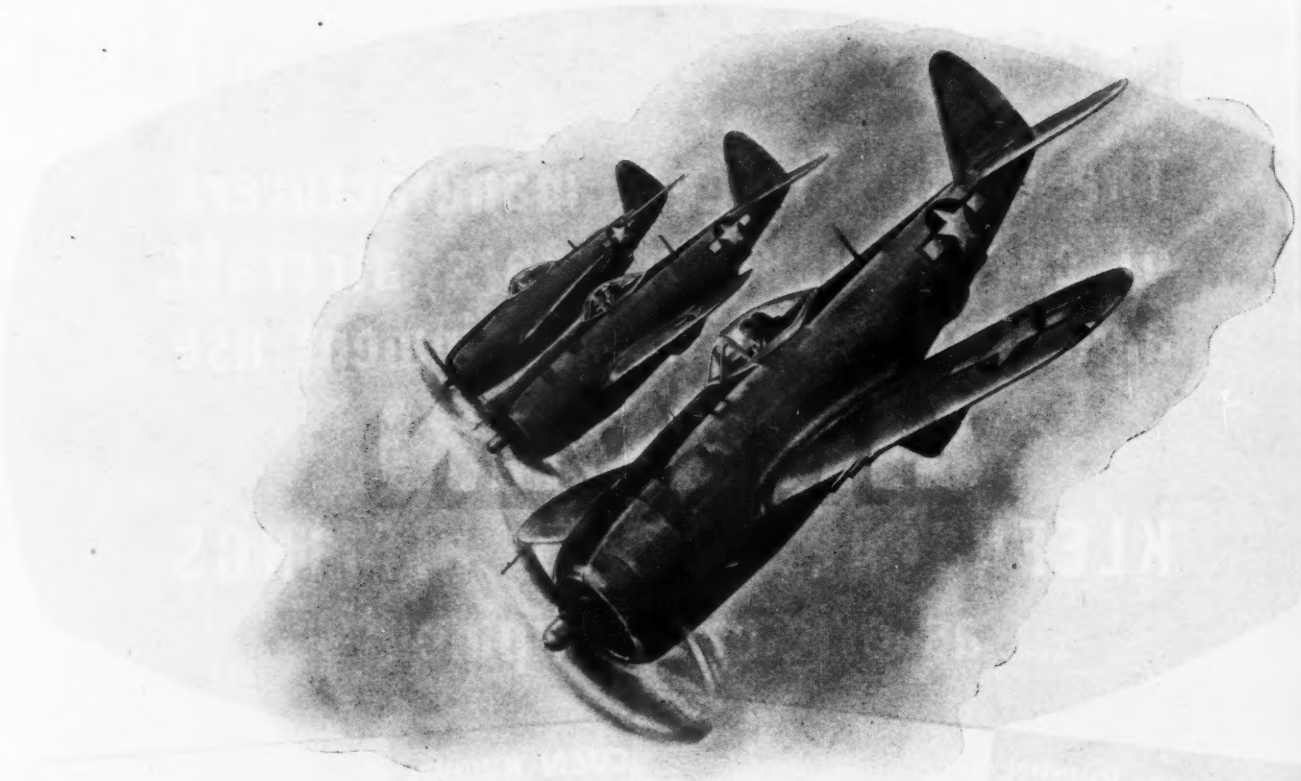
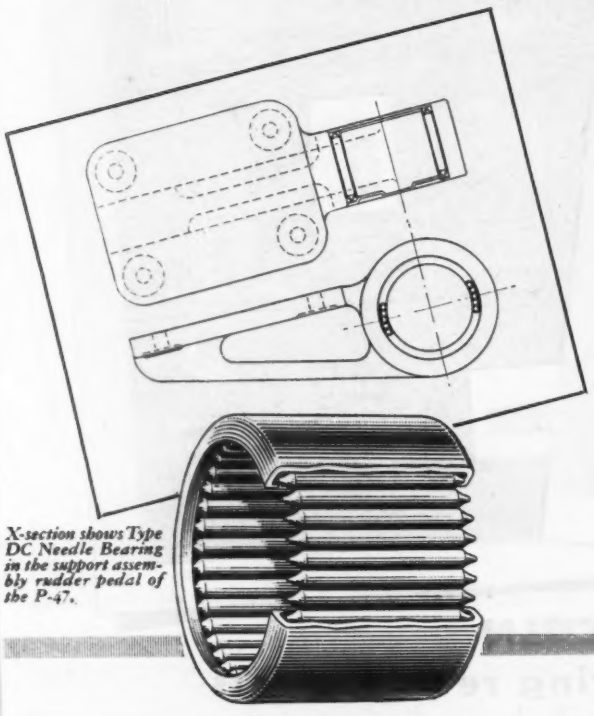


53 Torrington Needle Bearings Fly with the Republic P-47 Thunderbolt



X-section shows Type DC Needle Bearing in the support assembly rudder pedal of the P-47.

When you compare the advantages of Torrington Needle Bearings with the "must" requirements of aircraft engineering you see immediately why these modern anti-friction units are so widely used.

Their light weight, compact design, high capacity, greater stability and low friction coefficient offer a *combination* of advantages that is contributing to improved performance and increased efficiency in many fields.

With experience in thousands of different Needle Bearing applications, Torrington's engineering staff can assist you in securing maximum benefits of their use. Preview the possibilities *now* while your plans are on the drawing board. Send for a copy of the Torrington Needle Bearing Catalog which gives data on the range of types available for modern design needs.

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TORRINGTON NEEDLE BEARINGS

Ten Minute Hop By Helicopter—*Postwar*

Among American cities of 100,000 population or more—few are less than forty minutes from downtown area to airport—by surface transportation.

But with *helicopter* shuttle-service, most citys' major airports will be only *ten minutes* away—or *less*—from the rooftops of downtown hotels, garages, office buildings, bus and railroad stations.

And in the hands of professional pilots, such helicopter shuttle-service will be as safe as it is swift. For stoplights, street intersections, and heavy traffic will be eliminated—shaving time schedules to save as much as a half-hour at each end of your trip.

For short-haul service, too, from smaller to larger cities, and for trips to remote and otherwise inaccessible locations with no landing facilities, the helicopter will prove practical and useful.

At McDonnell, we are actively working on the development of the helicopter for peacetime uses. After victory, we'll tell you more concerning our plans and products. Until then . . . we'll continue to do our utmost to turn out more planes, parts, and plastics for war . . . to speed victory and peace.

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It's a spider—but a spider that can bring death, swift and terrible, with one sting...

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and what is KENYON?

KENYON is many people and many things, concerned with *custom precision craftsmanship*...

KENYON is a group of highly skilled workers, accustomed to dealing in ten-thousandths of an inch...

KENYON is an engineering team capable of working production miracles in the design and construction of precision parts and instruments...

KENYON is a fully-equipped testing and research laboratory, a modern machine plant...

BUT ABOVE ALL, Kenyon is a tradition of fine precision work, an *attitude* that can best be expressed by the unbroken promise "to *design, create* and *produce* precision parts to meet the manufacturer's specific need even if such a part has never been made before."

That's **KENYON**—and as such we are proud to have been of service to America's aircraft builders, supplying precision parts for planes like the "Black Widow". For the remainder of the war, and in the peace to follow, we will gladly perform similar service to *any* manufacturer with *any* precision problem.

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MEASURING in MILLIONTHS

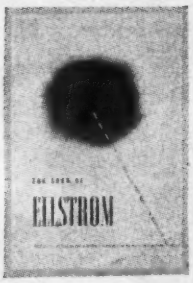
...for three generations

IN SWEDEN, before the turn of the century, Hjalmar Ellstrom, father of Elmer Ellstrom, the present head of the Dearborn Gage Company, built the first known gage blocks to accuracies of millionths of an inch.

That same Ellstrom was the production genius of the first company ever to sell master gage blocks commercially.

Today, his son and grandsons are carrying on in his footsteps

Hjalmar Ellstrom (in center) taken about 1900, with group of workmen in front of cottage where the first gage block sets were made.



by making gage blocks for industry throughout the world. In fact, they were the only ones to make a major improvement on Hjalmar Ellstrom's original gage block by successfully chromium plating the gaging surfaces of their blocks to increase their wearing qualities.

Yes, in three generations, craftsmanship in millionths of an inch has become a tradition with the Ellstrom family. This has prompted the writing of a booklet entitled, "The Saga of Ellstrom". It tells the complete story of the development of the gage block. Your copy will be sent you upon request, just write the Dearborn Gage Company, 22038 Beech Street, Dearborn, Michigan.

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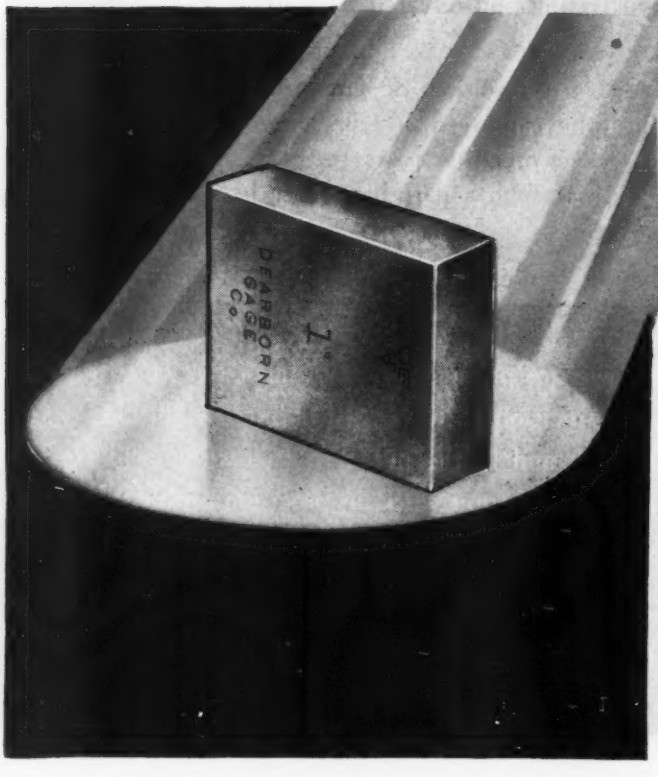

Ellstrom

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DEARBORN GAGE CO.

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Originators of Chromium Plated Gage Blocks

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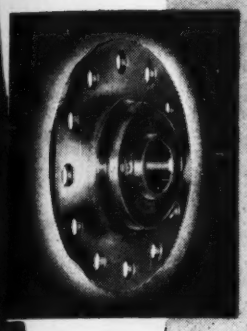

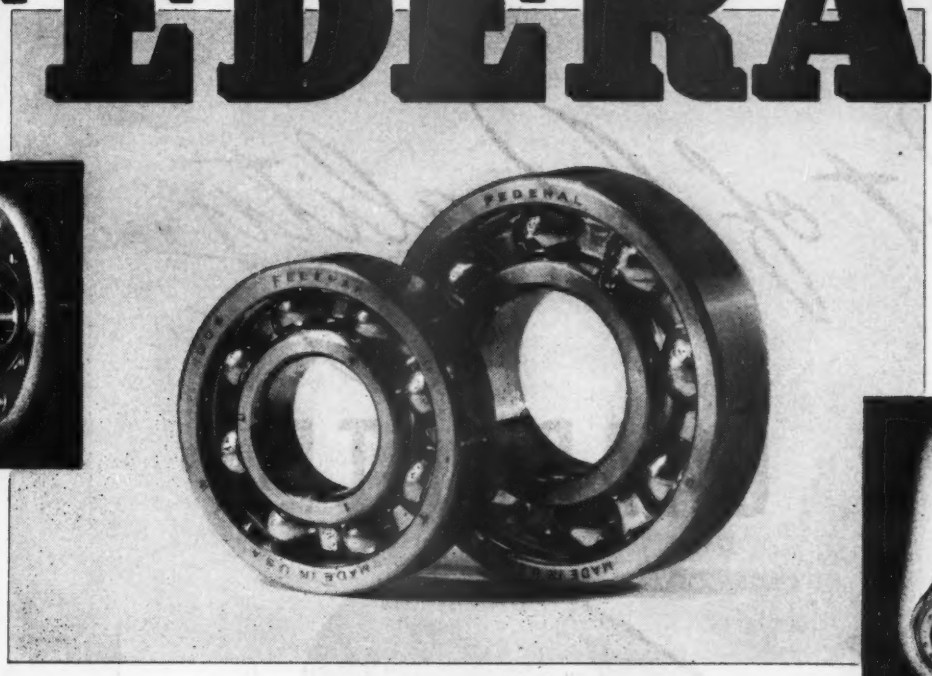

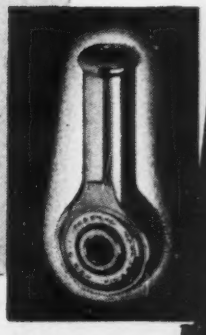

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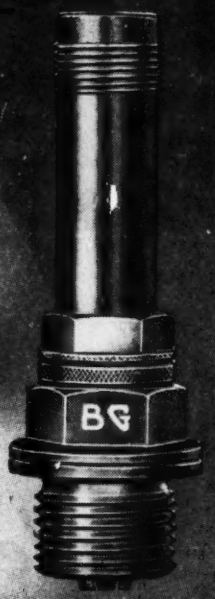

The uncompromising quality of BG Spark Plugs, the experience which has gone into their design and the vigilance with which they are manufactured endow them with the characteristics of *reliability* . . . economy of operation . . . long, efficient life. Because they *can* be relied upon for *regularly* faithful performance of duty, BG Spark Plugs have become standard on major airlines.

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Sirvene is different . . . not a single product, but a series of products, not just a synthetic rubber, but a custom-built, scientifically compounded elastomer. Using oil-resistant elastomers only, Chicago Rawhide chemical engineers develop a special Sirvene formula for each application. Sirvene products operate efficiently under conditions where other materials fail, because they possess exactly the right degree of elasticity and hardness and the proper resistance to dryness and age, extremes of heat and cold, oil and other solvents. Scientifically controlled laboratory production does the rest. The precision manufacturing processes required for Sirvene and the constant tests necessary to insure absolutely uniform performance are impossible under ordinary production methods.

Investigate Sirvene. If your postwar designs call for small, molded, pliable parts . . . diaphragms, boots, valve seats, gaskets, couplings or valve cups . . . call on Sirvene engineers to design a product which exactly fulfills your performance requirements.

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It is reported that . . . . . .

So tough is one new kind of glass that a searchlight lens made of it resists the heat of an 800 million candlepower lamp even though snow falls on the outside. *"Tuf-flex", Libby-Owens-Ford.*

get ready with **CONE** for tomorrow

Thermite (as used in incendiary bombs) has been applied to the demolition of metal structures. *McGraw-Hill Overseas Digest.*

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A new magnetic floor sweeper for factories looks like a lawn mower and picks up nails, scrap, small parts, and tools. *Stearns Magnetic Mfg. Co., Milwaukee.*

get ready with **CONE** for tomorrow

One of our aircraft manufacturers has complete plans for fitting a new fuselage, with luxurious interior, to the wings and engines of war-time bombers. *Consolidated Vultee Aircraft Corporation.*

get ready with **CONE** for tomorrow

In a newly-designed twelve-story parking garage, a single attendant can put away or bring out any one of 110 automobiles by merely pushing a button. *Park-O-Mat Co., Los Angeles.*

get ready with **CONE** for tomorrow

Plans are well advanced for annual trade fairs, on the European plan, in several American cities. *Bureau of Foreign and Domestic Commerce, Washington, D. C.*

get ready with **CONE** for tomorrow

Two hundred police chiefs recently witnessed a demonstration of a tiny radio receiver about the size of a pack of playing cards. *Hytron Corporation, Salem, Mass.*

get ready with **CONE** for tomorrow

The "Axonograph" is a device that photographically produces an axonometric drawing directly from a blueprint. *Glenn L. Martin Co., Baltimore.*

One manufacturer of electric appliances is already displaying his post-war models in order to gauge public tastes and preferences. *Proctor Electric Co., Philadelphia.*

get ready with **CONE** for tomorrow

"Fly-it-yourself" service is being planned on a basis similar to that of the familiar rented automobile service. *R. S. Robie, Boston.*

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A "slot-machine" mail box accepts payment, stamps a letter and holds it for collection. *"Mailomat", Pitney-Bowes, Stamford, Conn.*

get ready with **CONE** for tomorrow

A new molding plastic is non-organic and will stand heat to 420° centigrade. *Mycatex Corp., Clifton, N. J.*

A new chemical, when sprayed on the soil of gardens, is absorbed by the plant and kills many insects and fungi. By this means potato crops are said to have been increased as much as 40 bushels per acre. *Rohm and Haas Co.*

get ready with **CONE** for tomorrow

A prominent scientist states that he believes that a temperature of absolute zero (—273.1° C.) may soon be attained. *Prof. Peter Debye, Cornell Univ.*

get ready with **CONE** for tomorrow

The new space-saving square milk bottles are already in use by one dairy. *Sanitary Farm Dairies, Cedar Rapids, Iowa.*

get ready with **CONE** for tomorrow

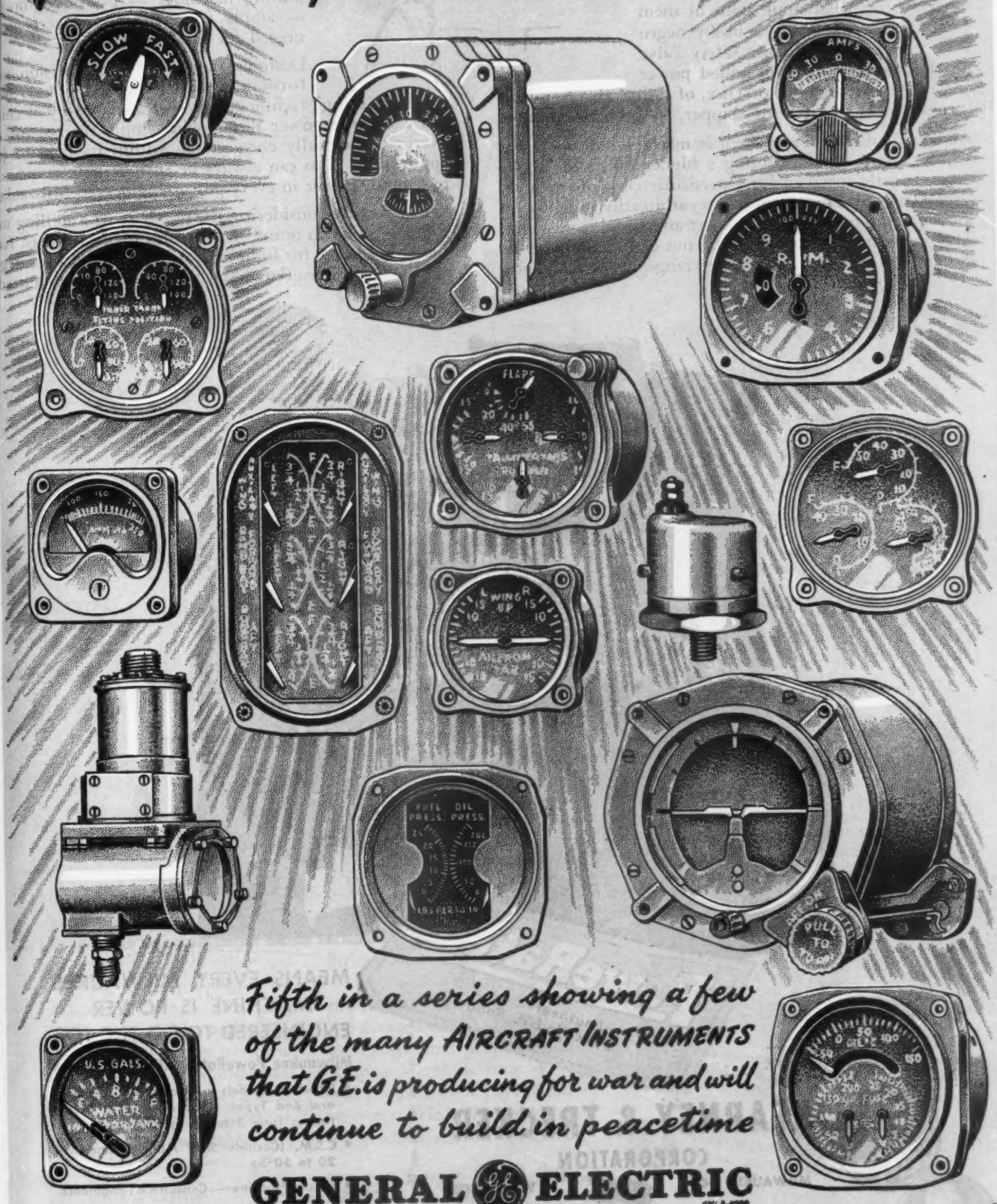
An electric motor has been built that develops 30 horsepower and weighs only 57 pounds. *General Electric Co.*

get ready with **CONE** for tomorrow

Paper forms for poured concrete are being used. *Sonoco Products Co., Hartsville, S. C.*

AIRCRAFT INSTRUMENTS

by GENERAL ELECTRIC

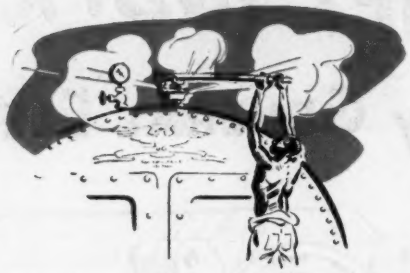


Fifth in a series showing a few of the many AIRCRAFT INSTRUMENTS that G.E. is producing for war and will continue to build in peacetime

GENERAL ELECTRIC

SCHENECTADY, N.Y.

HOLDING DOWN THE SAFETY-VALVE WAS A DANGEROUS WAY TO GAIN POWER AND SPEED!



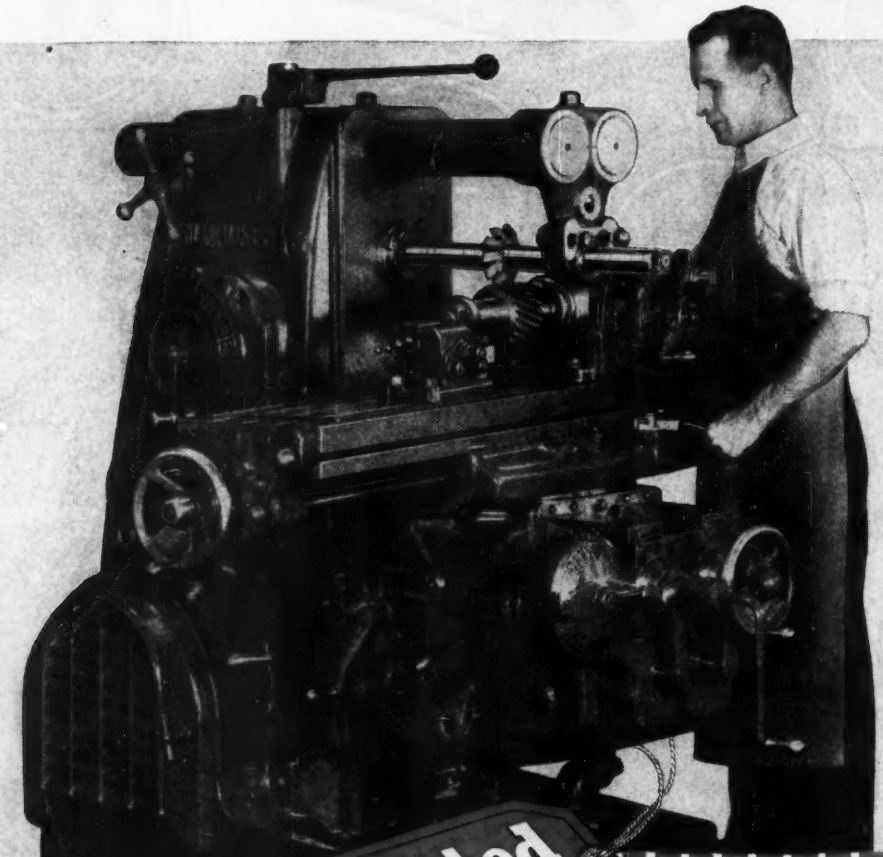
In the old steam-boatin' days when skippers and their craft raced one another on the Mississippi, some of them would resort to having a husky negro deck-hand hold down the safety valve on the boiler — to gain added power and speed. A dangerous practice, of course, that frequently resulted in disaster for skipper, steamboat and crew.

An equally doubtful expedient in machine-tool operation is the practice of substituting a higher hp motor above that normally specified for a particular class of machine. When you buy a milling machine, arbitrarily stepping up the motor hp to gain added power and speed is unsound. The power may be excessive and out of balance with its design, construction and proper range of performance.

It's an undesirable and unnecessary ex pedient when you know you can g milling machines — power-engineere — amply powered and properly eng neered for every class of job.

Designed and built for precision per formance with balanced power, Mil waukee Milling Machines are PoweRated—every machin has a definite power rating with ample reserve for a overloads normally encountered within its field of jo application. You can always be sure of ample and cor rect motor power in every power-engineered Milwaukee

When you are considering the purchase of a milling ma chine — think in terms of motor hp for heavy cuts, fee and speed range for light cuts. Check all the advantage of Milwaukee PoweRated Machines for your specific need



PoweRated
Engineered for a Specific HP. Range

3K Universal Machine — gashing slab milling cutter.

MEANS EVERY MILWAUKEE MACHINE IS POWER ENGINEERED TO DO THE JOB

Milwaukee PoweRated Milling Machines

- Standard Models — Horizontal, Vertical and Bed Types — available in Motor ranges from 3 to 25 hp
- C.S.M. (Carbide Steel Milling) machines 20 to 50 hp
- Special Machines—Consult K & T engineers.

KEARNEY & TRECKER CORPORATION

MILWAUKEE 14 WISCONSIN

Milwaukee Machine Tools

1001-P

CONTROLLED QUALITY

one of 8 big reasons why you can depend on Ampco Metal Parts

Quality control is one of the main features that set Ampco apart from ordinary sources of bronze — that assure you of an engineered alloy unvarying in its properties today, next month, or a year from now. This uniformity is important when performance of your equipment depends on material that *always* meets predetermined specifications. • Ampco's laboratory control — a long-established feature of Ampco service — is carried out by the largest corps of technicians in the bronze alloy field.

Ampco also offers you the production "know-how" to *produce* to a standard. • Utilize the exceptional properties of Ampco Metal in your post-war products — it pays! Send us your prints for helpful suggestions. Ask for bulletins.

Only from Ampco can you get *all* of these services and benefits:

1. Distinctive properties of resistance to wear, impact, fatigue, corrosion.
2. A series of engineered alloys—with physical properties to fit your application.
3. Quality control to hold these properties within narrow limits.
4. Diversified production facilities — coordinating in one place all the commonly used metalworking processes.
5. Engineering and production "know-how" to give you a practical manufacturing program.
6. A nation-wide organization of field engineers to assist you.
7. A record of proved performance in hundreds of leading makes of equipment.
8. A national reputation that makes Ampco Metal parts a sales asset.

Specialists in engineering, production, finishing of copper-base alloy parts

AMPCO Metal
The Metal without an Equal

Ampco Metal, Inc.
Dept. A-1
Milwaukee 4, Wisconsin
Ampco Field Offices in Principal Cities

AW-11

CREATIVE ELECTRICAL ENGINEERING

There are few industries in which post-war planning does not involve *Creative Electrical Engineering* ability of the highest order. The exacting competitive situation developing demands topnotch skill.

On its record, LELAND Electric has earned your consideration. Our experience and ingenuity in solving tough electrical problems may prove immensely valuable to you.

We invite you to consult with us.

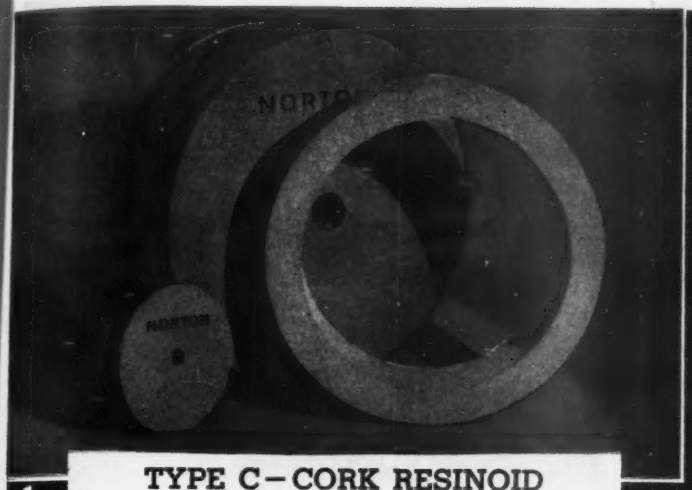
THE Leland
ELECTRIC COMPANY

DAYTON 1, OHIO

In Canada: Leland Electric Canada Ltd., Guelph, Ontario

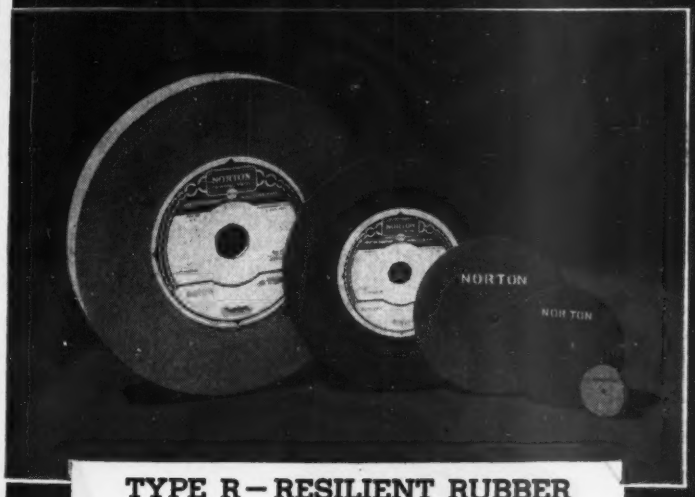
Alternator

Self-excited, can be used with electric motor or gasoline drive, up to 2½ KW output, genefal purpose electric power supply.



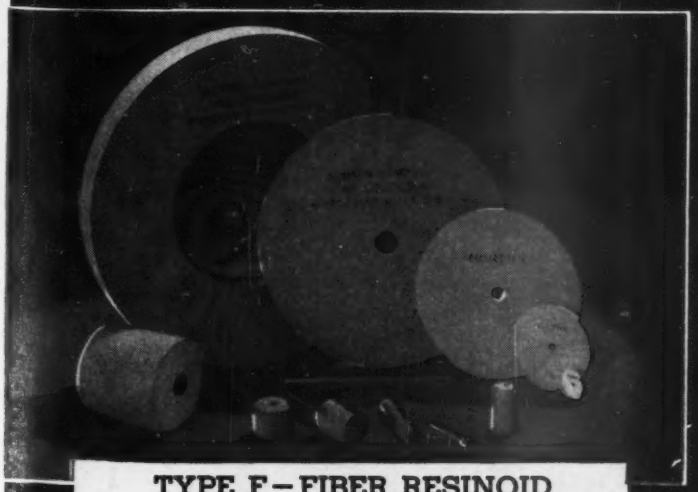
TYPE C—CORK RESINOID

Interested in getting readings as low as 2 micro-inches? Then try these and see what perfection really is. For operation at speeds up to 6000 s.f.p.m.



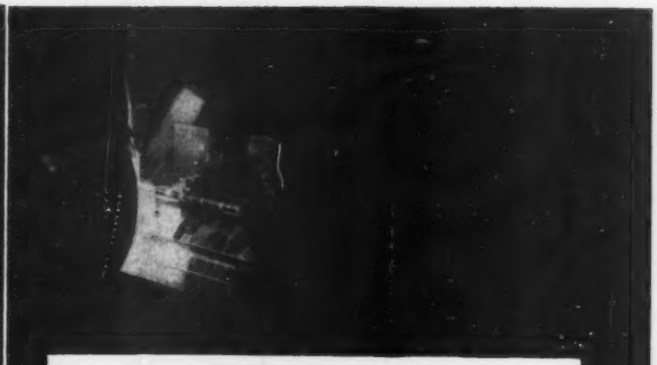
TYPE R—RESILIENT RUBBER

Do you like that s-o-f-t resilient action, where the wheel hugs the work without bump or chatter? Then use these for operation at 3300-6000 s.f.p.m.



TYPE F—FIBER RESINOID

Want to combine a light grind plus a polish in one operation? Use these for operation up to 7500-9000 s.f.p.m.



Announcing NORFLEX! POLISHING WHEELS!

FROM polishing a tap or drill to breaking down corners of sheet stock or removing nicks or burrs from gears and other parts NORFLEX* Polishing Wheels cover the field thoroughly and completely. They come in three types, Cork Resinoid, Resilient Rubber and the latest Norton development—Fiber Resinoid. All three will now be known as NORFLEX* Polishing Wheels—all three develop a high finish.

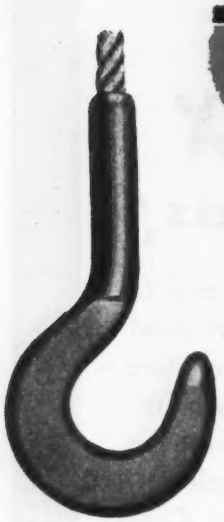
Your Norton abrasive engineer or Norton distributor will give you the complete story on NORFLEX* Polishing Wheels.

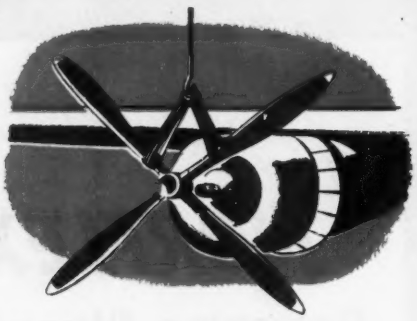
*Trade-mark

NORTON COMPANY
Worcester 6, Mass.

NORTON ABRASIVES

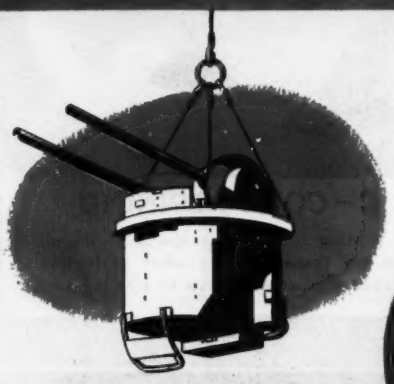
LIGHTEN LIFTING PROBLEMS
with P&N Sling Fittings, Hooks and Rings





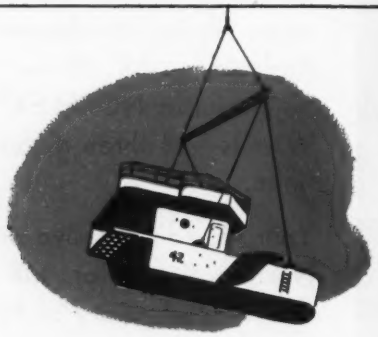
DIRECT LINE SWAGED HOOKS

P & N Direct Line Swaged Hooks are made of stainless steel and so designed that the load is on a direct line from the cable. Tests have shown their holding factor is in excess of cable. Available for 1/16 to 1 inch cable.



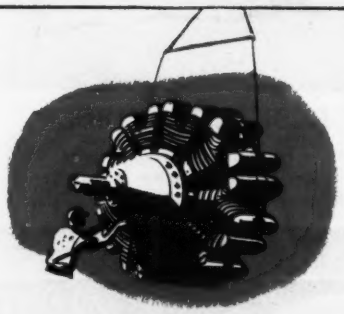
P & N CLEVIS RINGS

Made of alloy steel, these P & N Clevis Rings are carefully formed to retain the full strength qualities of the steel. They are cadmium plated and will fit any standard cable terminal. Available in sizes for 1/16 to 1 inch cable.



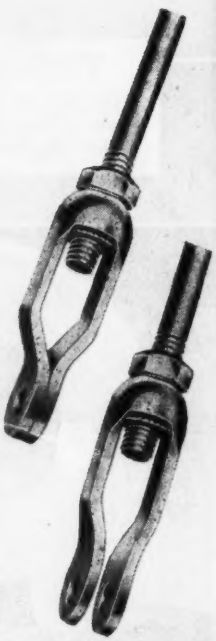
SOCKETYPE CABLE TERMINALS

Stamped and drawn from 41/30 alloy steel with a strength factor greatly in excess of cable, their use saves cable—allows cable to swivel freely when loose, thus eliminating kinking—and also provides a smooth foul-free installation. Available in both fork and eye types to fit cables of 1/16 to 1 inch diameter.



P & N COMMERCIAL ROD ENDS

Designed for use with spreader bars, P& N Rod Ends are equally adaptable to push-pull rods such as aircraft throttle controls and automotive tie and brake rods. Their use allows an unusually wide range of adjustment and is positive when adjustment is set. Available in both fork and eye types for 1/8 to 1 inch rods.

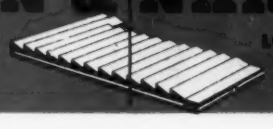


PN

POULSEN & NARDON, INC.

TERMINAL BOX 2398 LOS ANGELES 54, CALIFORNIA

Established 1922



New Folder Available to Industry Personnel

Flight Research looks through the clouds...into *tomorrow*

DYNAMIC, continuing *research* has always been the lifeblood of the Sperry organization. In recent years, *Flight Research* has become an increasingly important part of our research effort.

In a single recent month, Sperry operated ten airplanes, and made 181 test flights for 21 different projects, involving 725 test and flight personnel.

Sperry flight personnel are qualified to operate most types of commercial and military airplanes.

And now, to expand these activities further, Sperry has established improved facilities at MacArthur Airport, on Long Island. Here, with accommodations for the largest airplanes, complete in every particular, *Flight Research* will continue to transform new ideas into practical devices.

The problems to be solved are innumerable—one leads to another. At present, some of them are secret, in the interest of Military security.

But tomorrow—many of the wonders developed for wartime use will need to be adapted to peacetime:

Radar . . . automatic flying devices . . . instrument landing techniques . . . airport traffic control devices . . . and many others.

Sperry's *Flight Research* will accept the challenge of peacetime as it has accepted the problems of wartime. As a result, flying will be safer, swifter, more economical, and more comfortable.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

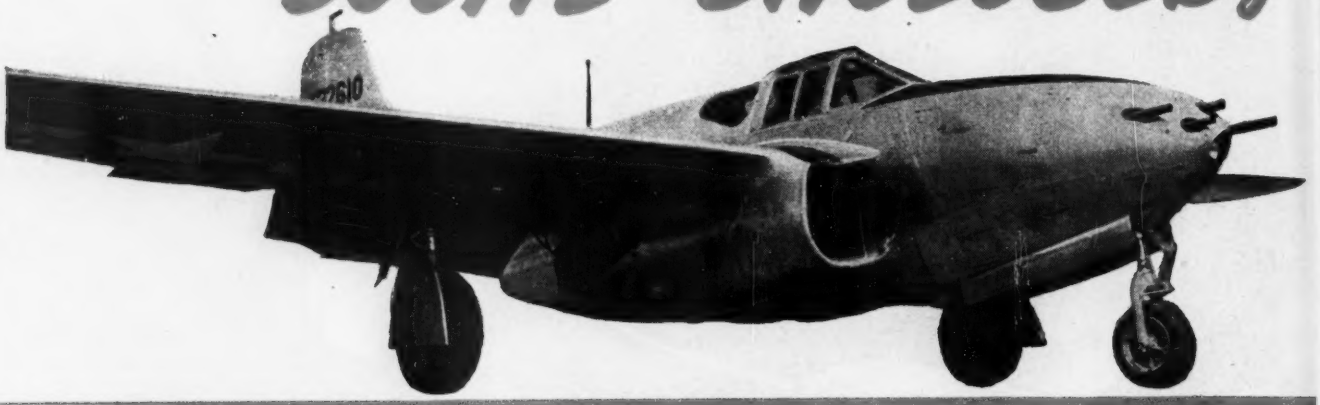
Division of the Sperry Corporation

★

LOS ANGELES • SAN FRANCISCO • NEW ORLEANS
HONOLULU • CLEVELAND • SEATTLE

GYROSCOPICS • ELECTRONICS • RADAR • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

JET PROPELLED! "LUCITE" ENCLOSED!



TOP AND SIDE OF COCKPIT ON

BELL AIRCRAFT'S P-59A AIRACOMET

Protected by Du Pont "Lucite" Methyl Methacrylate Resin Sheets

CHIEF distinction of this Army Air Force jet-propelled plane is the absence of a propeller—which allows it to be built low to the ground. Weighing more than five tons, the P-59A Airacomet is practically vibrationless and has a speed of over 400 miles per hour—driven by the powerful thrust of the gases leaving the nozzles of the jet engines.

Transparent enclosures of "Lucite" methyl methacrylate resin are installed in the top and side sections of the cockpit canopy. In addition, a dome-shaped lens of "Lucite" protects the landing light located in the tip of the nose.

The crystal-clear *transparency*, light weight, excellent tensile properties, ease of forming, finishing and mounting make it suitable for a wide variety of aircraft applications.

E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, N. J., or 5801 South Broadway, Los Angeles 3, California. In Canada: Canadian Industries, Ltd., Box 10, Montreal.

These are top and side sections of cockpit enclosure. Worker is polishing dome-shaped "Lucite" landing light lens.

DU PONT

DU PONT PLASTICS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

HERO ★★★

Soon he'll be home from the wars—triumphantly home . . . to what?

The cold facts are these:

Nearly one-third of our fighting men are returning to "homes" that are without running water . . . 35 per cent of the dwelling units in this country are without sanitary plumbing or bathing facilities of any kind . . . and American slums have bred the highest rate of juvenile crime in our history.

In short, there's still a war to be won here at home!

Our weapons are the mightiest on earth. Our manufacturing productivity is equal to half the world's total capacity . . . our basic economy and our currency are sound . . . and our faith in the American Ideal is stronger than ever before.

The time to start fighting that war is now. Delay could mean defeat, and the loss of all that our sons have fought and died for. Victory will mean a great new age of peace and prosperity, with jobs and security for all.

The engineers of the basic machine tool producers can help the men of government and of industry to win that victory . . . to plan now the reconversion of our tremendous wealth of resources, skills and machinery to all-out production for a better America.

One of these engineers is a Bryant man. We urge you to call him in today.

BRYANT CHUCKING GRINDER COMPANY SPRINGFIELD VERMONT, U.S.A.

Dead-Eye Dick

on a saddle in the sky . . .

He's a throwback to the Wild West of tradition . . . a two-gun man like his great grand dad, hawk-eyed, quick on the trigger . . . riding herd over half the globe in a bomber, enforcing law and order with a brace of .50 calibers that kill up to eight hundred yards . . . sighting and firing in the split-seconds a hostile fighter flicks within his range . . . And his saddle is an armored, steel-and-plastics turret that turns at a finger touch towards any target in any direction . . .

Some of these hydraulically operated turrets are now powered by the EE 709 . . . a small electric motor of our own design which we are privileged to make for this particular function. Weighing only 16.5 lbs., the EE 709 is built for short period peak loads; delivers 2.5 hp intermittently at 2150 rpm, or on continuous duty, 1.2 hp at 2500 rpm. Special precision-made spiral bevel gears of nitralloy, nitrided to extreme hardness, housed in a grease-filled gear box, permit right-angle pump mounting, and save space. Compound winding of glass tape insulated coils provides high starting torque and improved speed control. An integral fan on the armature shaft forestalls any possible cooling failure. The brush mechanism has beryllium copper springs. Both motor and gear box have full ball-bearing construction.

PRECISION assembled by hand, the EE 709 is one of the most reliable and efficient units of special purpose concentrated motive power ever made . . . And only one of a large line of small light motors and other auxiliary and accessory items for aircraft—designed, engineered, manufactured by Air Associates . . . Inquiries are invited.

• *New orders on motors are now assured early delivery.*

AIR ASSOCIATES, INC.

TETERBORO, N. J. . . . *BRANCHES:* CHICAGO, DALLAS, LOS ANGELES . . . ENGINEERS & MANUFACTURERS OF AIRCRAFT SPECIALTIES . . . SUPPLIERS OF ALL TYPES OF MATERIALS TO THE INDUSTRY SINCE 1927

Keeping Production On the Move with

SIOUX Aircraft WET VALVE SEAT Grinding Machine

For Radial Motors

In this plant—SIOUX is doing a production job on radial motors.

Write for Full Details

STANDARD THE WORLD OVER

ALBERTSON & CO., INC. SIOUX CITY, IOWA, U. S. A.

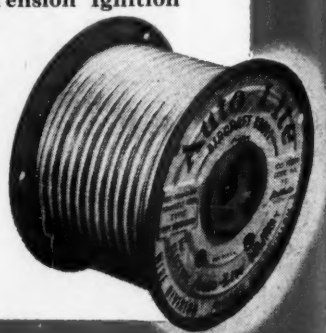
BUY WAR BONDS

"Precision bombing" is more than a catch phrase. This American achievement is playing a major role in winning the war.

Wire helps the bombardier to score a bull's eye. As he approaches the target, he takes over guidance of the ship from the pilot. Wire helps him direct its course surely and accurately to the target.

There's in excess of ten miles of wire in a Super Bomber . . . for "inter-com", landing and signaling lights, connections that relay the condition of engines and fuel.

Auto-Lite can and does make every type of the wire that is used in these American Super Bombers. You can get complete details—in Form No. 838 covering Low Tension Cable; in Form No. C-503 covering Steelductor Cable, the High Tension Ignition Wire now used in the majority of America's fighting and bombing planes. A request will make sure these valuable and imformative bulletins are in your files.



THE ELECTRIC AUTO-LITE COMPANY

Wire and Cable Division

SARNIA, ONTARIO PORT HURON, MICH.

AUTO-LITE AIRCRAFT WIRE and CABLE

TUNE IN "EVERYTHING FOR THE BOYS" STARRING DICK HAYMES — EVERY TUESDAY NIGHT — NBC NETWORK

AGAIN EMYCEL* MAKES FABRIC FINISHING NEWS!

DIXIE CLIPPER AFTER 2 YEARS IN WAR ZONES GOES BACK ON RUN—WITH NO FABRIC RECOVERING NECESSARY

Emycel-finished fabric needs only cleaning and it's ready for new color-coat

Something of a new record was hung up by Pan American Airways' Dixie Clipper when she reported back from the war zones to shed her camouflage.

Emycel finished fabric surfaces were found to be still in service trim after two years—*85% of which was spent in the tropics.* The surface needed only to be wiped off with a cleaning solvent and covered with one coat of grey, high-gloss Emycel to match the natural metal appearance of the rest of the plane.

Two Important Features of EMYCEL made this record Possible

EMYCEL IS ROT PROOF. Special fungicides incorporated in Emycel prevent fabric rotting caused by fungus spores which are especially prolific in the tropics and which propagate rapidly in the fabric enclosed areas of wings and control surfaces. The patented Emycel principle of rot proofing aircraft fabric is made mandatory in U. S. Navy Process Spec SR-70 D.

EMYCEL PROTECTS FABRIC FROM INJURY. Its super-flexibility resists impact of flying objects at sub-zero or high temperatures. Yet Emycel maintains a tautness comparable to that of any other fabric finish used on aircraft.

Emycel is C.A.A. approved and backed by three years of world-wide service on all types of aircraft. Write for "Fabric Finishing with Emycel"—Dept. 805.

ROXALIN Flexible FINISHES
INCORPORATED
ELIZABETH, N. J. • NEW JERSEY

*Patented

WATCH ROXALIN IN AVIATION

1918 First crude radio sets used by the Jennies and DeHavillands of World War I were powered by wind-driven generators built by Westinghouse. They were relatively heavy and bulky by today's standards.

Since the days of DH's . . . answering aviation's need for

"MORE WATTS... LESS WEIGHT!"

Since the day the first DeHavillands and Jennies found a need for power to energize the earliest aircraft radios, the aircraft industry has voiced a recurrent need:

"Give us WATTS—but hold down WEIGHT!"

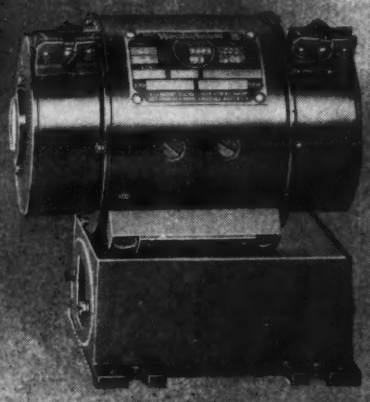
From that day to this, Westinghouse engineers have worked hand-in-hand with aircraft builders and designers to supply that need. How well they have succeeded may be judged by the progress of d-c generator design. Today's Westinghouse Aircraft Generators supply the highest output-to-weight performance.

Dynamotors—for transforming d-c power to higher or lower voltages—also have grown smaller and lighter in proportion to their ratings, thanks to Westinghouse engineers. The progressive development shown here has contributed to the wider and greater usefulness of electrically powered auxiliaries and controls in planes.

Westinghouse efforts toward taking the weight out of kilowatts are continuing—and will continue. They offer another sound reason for making Westinghouse your electrical partner in aviation progress. Westinghouse Electric & Manufacturing Co., Lima, Ohio. J-03210

Westinghouse

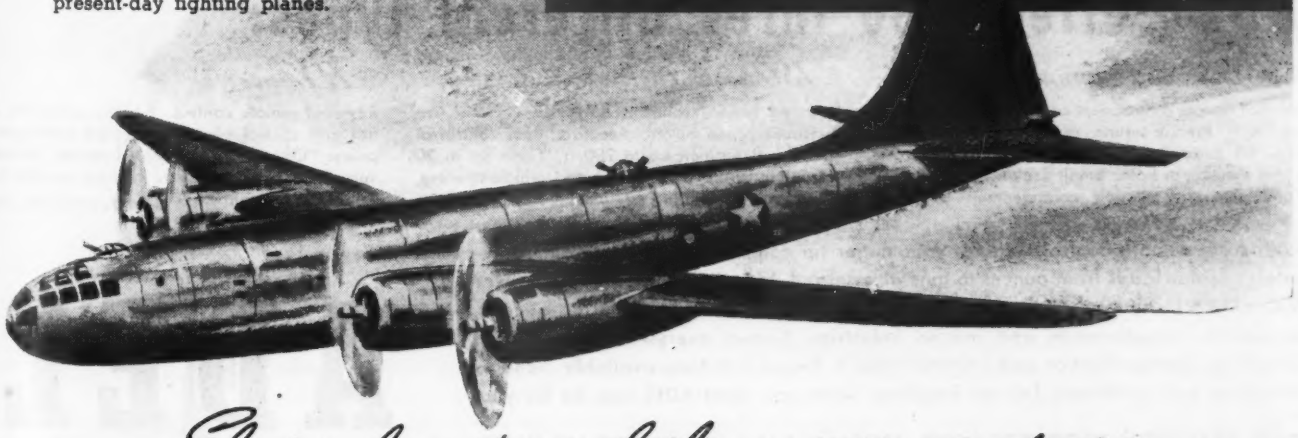
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE



1931 This light, minimum-ripple dynamotor—first of its kind—was introduced by Westinghouse.

1934 The trend toward lightness and compactness advanced again with this improved dynamotor.

1944 Small, sleek and powerful in proportion to its weight, today's Westinghouse dynamotors further contribute to weight reductions in the communications and control systems of our present-day fighting planes.



Electrical partner of the aviation industry

YESTERDAY . . . TODAY . . . TOMORROW

REMOTE CONTROL

−65° F to +165° F

LAND–SEA–AIR

ADEL controls will save muscular effort in steering, braking, door-opening, load handling, etc., on buses, trucks and tractors.

ADEL remote controls assist with steering, engine maneuvering, clutching, braking and reversing—all with finger-tip movement of a small handle.

ADEL places power at your finger tips for operating cowl flaps, wing flaps, dive flaps, bomb bay doors, machine gun turrets, emergency exits, landing gear, etc.

ADEL systems now serve the railroad industry to operate reversing, braking, signals and other controls. Impervious to all types of weather and temperature changes.

ADEL controls lift and lower scrapers, operate tandem equipment, save strain and speed the job for busy contractors.

ADEL offers you three different types:

*** *ISOdraulic (manual)***

Manual remote control. Self-contained. Operates up to 150 ft. Precise settings over temperature range of −65 F. to +160 F. with master or slave at either extreme or both. Small size and light weight. Tandem control station arrangements possible.

*** *ISOdraulic (power)***

Powered remote control. Adaptable to any size hydraulic prime mover. Accurate, easy control of speed and position up to 200 ft. Flows up to 20 GPM. For airplane flaps, ship and vehicle steering, clutches, road building equipment, etc.

*** *HYdronic***

Powered remote control. Employs electronic sen ing and control elements coupled with hydrau power. Operates over great distances. Extreme versatile units adaptable to the most complex insta lation requirements.

**Trade Mark Registered*

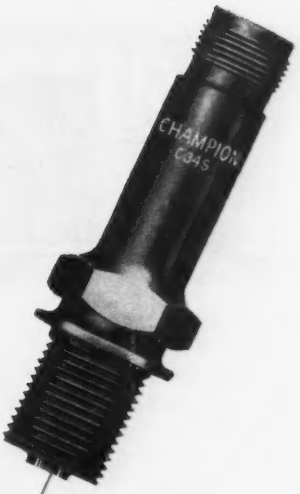
With ADEL remote control systems, your finger tip commands will move and accurately position loads from ounces to tons with rugged, versatile hydraulic power. Over 500,000 ADEL hydraulic units comprising 300 types and sizes now serving aircraft, armament, transportation and marine industries. Known everywhere for Design Simplicity, Standardization and DEPENDABILITY. Recent brochure available. Send us details of your problems. Let our engineers show you what ADEL can do for you.

ADEL PRECISION PRODUCTS CORP., BURBANK, CALIF., HUNTINGTON 17, W. VA.

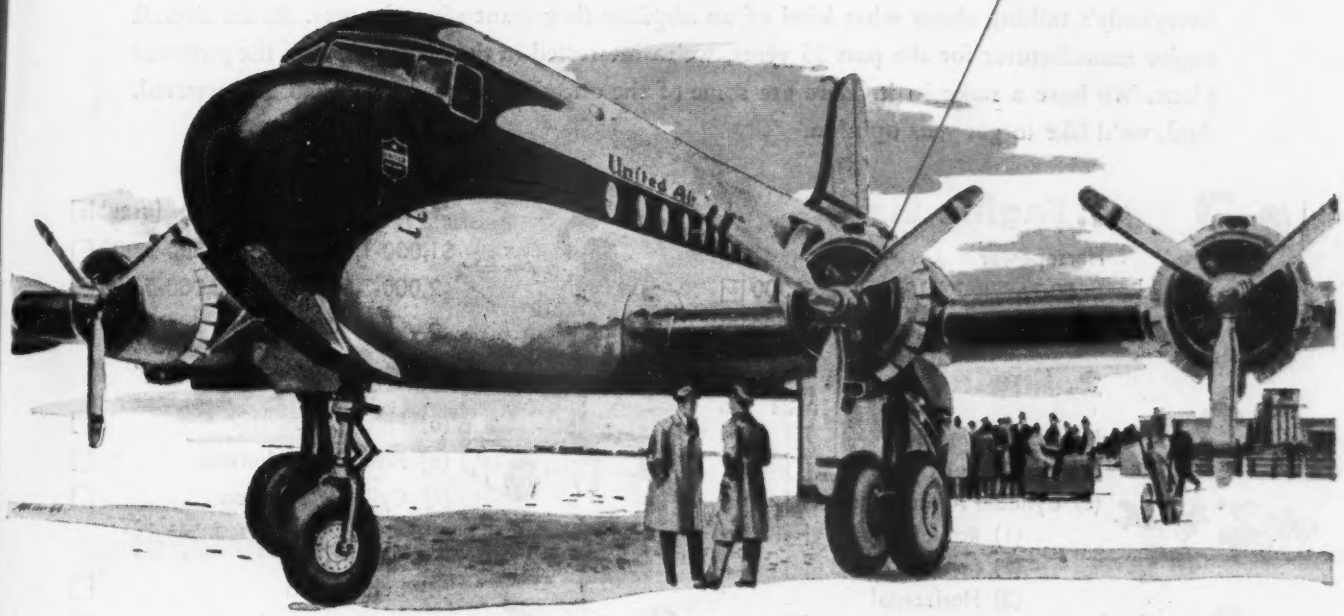
After VICTORY . . . *the* ADEL-AGE

Buy U. S. War Bonds and Hold Them

UNITED
AIR LINES



WHERE MAINTENANCE OF SCHEDULES REALLY COUNTS . . .



. . CHAMPION SPARK PLUGS

INSURE MAXIMUM DEPENDABILITY

C26—Unshielded

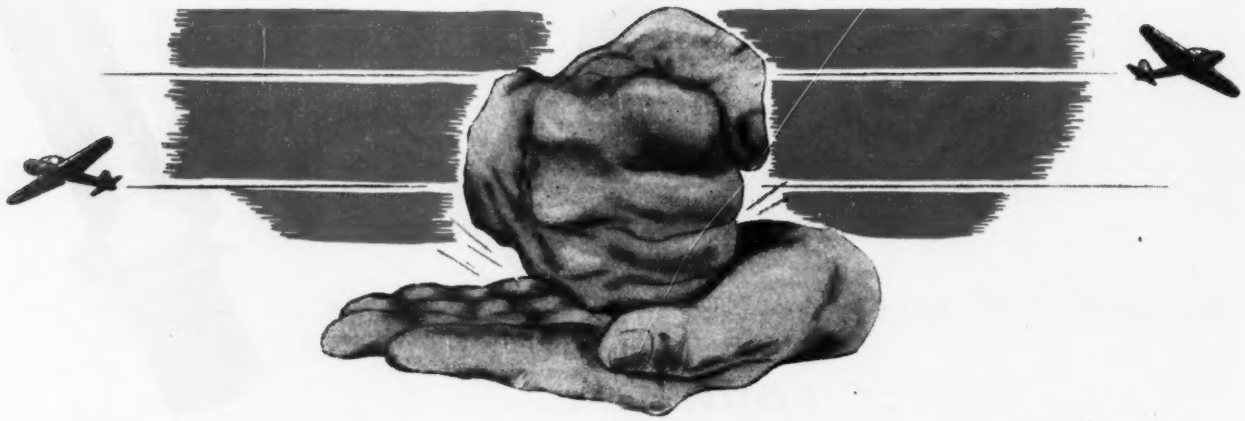
Looking ahead to the days of peace, United Air Lines recently announced placement of orders for 50 four-engined Douglas luxury liners for immediate postwar use. Meantime United has set exceptional performance records in the service of the nation, both military and civilian, by operating almost 100,000 schedule miles daily with less than two-thirds the number of planes used to fly 81,000 schedule miles in 1941. Champion Spark Plugs now used exclusively by United on its Mainliners and Cargoliners have contributed substantially to this outstanding service record. Thus, once again, Champion Spark Plugs demonstrate in an exceptional way the inherently high caliber of their dependability—dependability that has established Champions as the preferred spark plug for all types of service on land, water and in the air. Champion Spark Plug Company, Toledo 1, Ohio.

ARMY E NAVY

BUY MORE AND MORE WAR BONDS UNTIL THE DAY OF VICTORY

INSTALL CHAMPIONS AND FLY WITH CONFIDENCE

THIS QUESTIONNAIRE IS IMPORTANT TO YOU



Let's get down to FACTS

Everybody's talking about what kind of an *airplane* they want after the war. As an aircraft *engine* manufacturer for the past 25 years, we're interested in the *power-plant* of the post-war plane. We have a stake in it. Here are some of the questions we think need to be answered. And, we'd like to get *your* opinion.

1. Engine Size

Horsepower

50-75 ☐ 75-100 ☐ 200-300 ☐
100-150 ☐ 150-200 ☐ over 300 ☐

2. Engine Type

	Liquid	Air
(a) Cooling Medium	☐	☐
(b) Number of Cylinders	☐	
(c) Cylinder Arrangement	☐	
(1) Radial	☐	
(2) In-Line	☐	
(3) Horizontal Opposed	☐	

3. Power Cycle

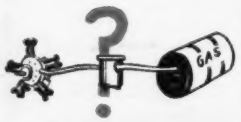
(a) 2-cycle ☐
(b) 4-cycle ☐

4. Features

(a) Geared Propeller ☐
(b) Noise Reduction ☐

5. Price Range (useable)

$1,000-1,500 ☐ $1,500-2,000 ☐
2,000-3,000 ☐ 3,000-5,000 ☐
5,000-10,000 ☐



6. Carburetor

(a) Float Carburetor ☐
(b) Pressure Carburetor ☐
(c) Cylinder Injection ☐

7. Type of Installation

(a) Submerged ☐
(b) Front of Fuselage ☐
(c) Back of Passengers ☐
(d) In Wings ☐

The American public always gets what it wants. Will you help us find out just what that is in terms of aircraft engines?

And, Thanks!

Send your answers to

KINNER MOTORS, INC.
635 W. Colorado Boulevard
Glendale 4, California

I am a: private plane owner ☐
fixed base operator ☐
aircraft manufacturer ☐

KEEP ON BUYING BONDS

Kinner

1919 BUILDERS OF DEPENDABLE AIRCRAFT ENGINES FOR A QUARTER CENTURY 1944

For Testing HIGH PRESSURE *Aircraft Systems and Components*

Why waste time and money experimenting with and developing hydraulic testing equipment, when we have a complete line of standard machines ready for you. We specialize in hydraulic test machines and can save you the time and expense of duplicating expensive development work already performed successfully by us for others.

Greer HYDRAULIC TEST MACHINES

The equipment illustrated indicates the range of Greer Hydraulic Test Machines available for testing high pressure aircraft systems and components. A simple, self-contained source of hydraulic power, complete with gasoline engine, is shown at the top. The machine at the bottom is a multi-purpose laboratory unit. Contact our Engineering Department for your specific requirement.

GREER HYDRAULICS, INC., 39 West 60th Street, NEW YORK 23, N. Y.

Approved

BY BOTH

ARMY & NAVY

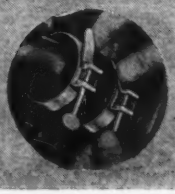
THE MARMAN UNIVERSAL HOSE CLAMP—SERIES 820

Now, for the first time, one clamp combines *all* these features: ✓ stainless steel construction ✓ re-usability ✓ self-locking screw with high back-off torque ✓ corrosion resistance ✓ adjustability —3 sizes handle hose diameters from $^{11}/_{16}$ to 3-$^{9}/_{16}$ O. D. ✓ non-slipping band conforms to hose contour and clamps irregular shapes with equal efficiency.

Marman also makes standard fixed contour hose clamps in stainless steel and aluminum alloy, as well as the Marman Quick-Coupler in stainless steel or aluminum alloy. Write today for *new* folder, Series 820.

MARMAN
PRODUCTS CO. Inc.
940 WEST REDONDO BOULEVARD
INGLEWOOD, CALIFORNIA

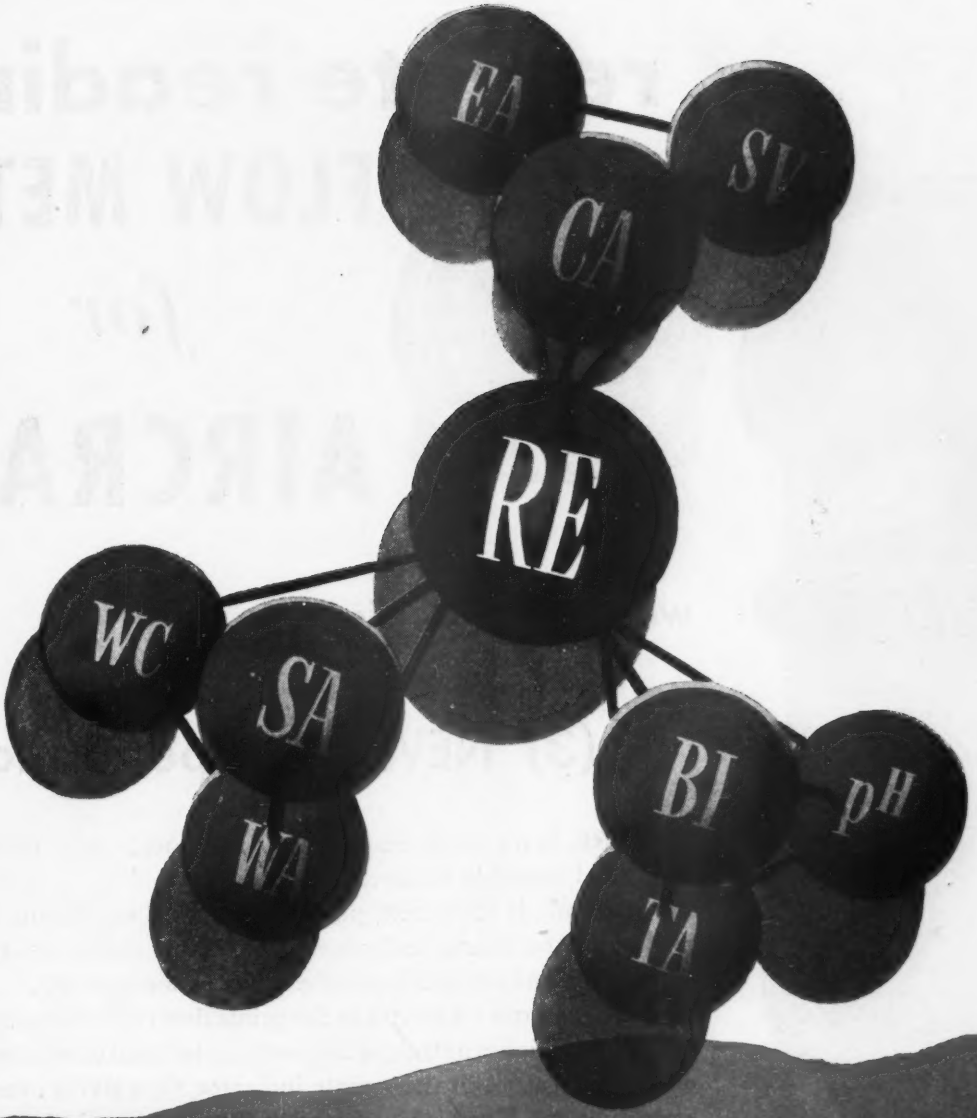
EASIER TO INSTALL!



1. Retract screw fully. Wrap band around hose and insert end through opening in saddle.

2. Pull up snug, fold band down inside saddle, tighten screw.

Marman's exclusive swivel-action nut rocks on swivel pins and when screw is tightened, tips down, cinches band and prevents slipping.



THIS IS WHAT HAPPENS WHEN YOU WASH AN AIRPLANE

Correctly cleaning an airplane is no simple operation... these elements must go into action...

Wetting Action *(WA)* must lower surface and interfacial tensions and allow the cleaning solution to penetrate to surface of the base. Emulsifying Action *(EA)* must disperse grease and oil as tiny globules, and by suspension prevent re deposition. Solvent Action *(SA)* put soils into solution. Colloidal Activity *(CA)* must disperse solid soils into minute particles which may then be easily removed. Water Conditioning *(WC)* removes or controls the elements which cause water hardness.

Correct Buffer Index *(BI)* assures ability to absorb either alkaline or acid soil, thus prolonging efficiency of the solution. Proper *pH* assures the correct measure of energy of alkalinity and Total Alkalinity *(TA)* must supply maximum active cleaning energy.

In formulating a cleaning compound, therefore, it is obvious that no one factor is a magic key to all problems. The answer is in determining the relative value of *all* these factors as they apply to your problem.

Putting these factors into correct balance is a responsibility you can entrust to Turco chemists—a responsibility for which their two decades of Research and Experience *(RE)* have well qualified them. *Take your problem to Turco.*

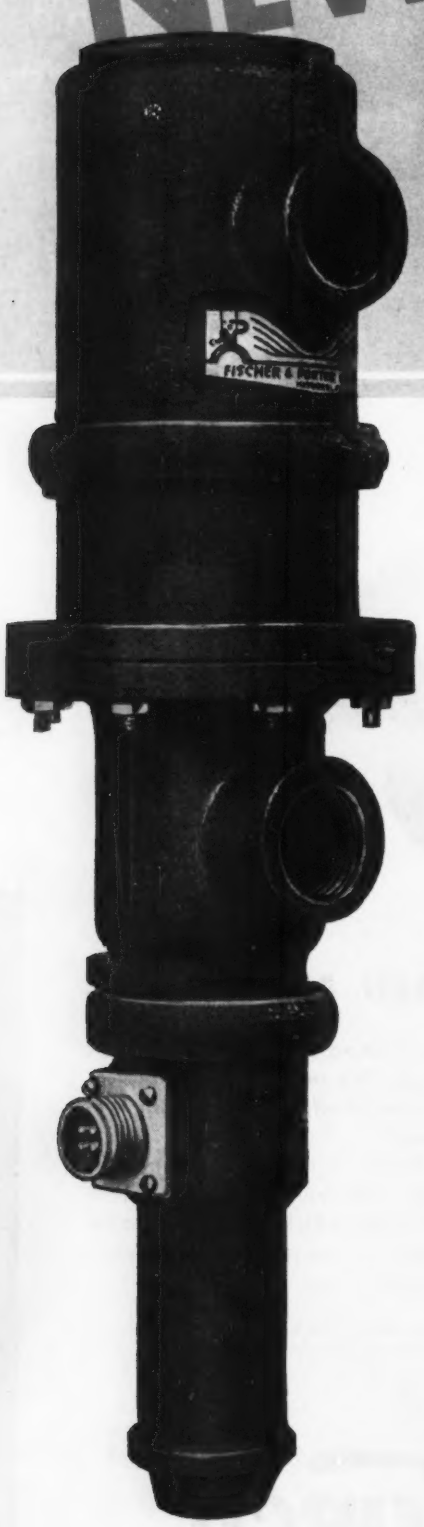
For a fuller explanation of these vital factors, write for Turco's Booklet on your firm letterhead, please.

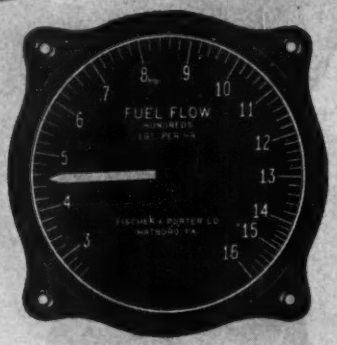
TURCO

INDUSTRIAL CHEMICAL COMPOUNDS

TURCO PRODUCTS, INC. *Main Office and Factory:* 6135 S. Central Ave., Los Angeles 1, Calif. • *Southern Factory:* 1606 Henderson St., Houston 1, Texas • *Chicago Office and Factory:* 125 West 46th Street, Chicago 9 • *Offices and Warehouses in All Principal Cities*

a NEW remote reading FLOW METER *for* AIRCRAFT





with (1) new circuit
(2) New features
(3) NEW high performance!

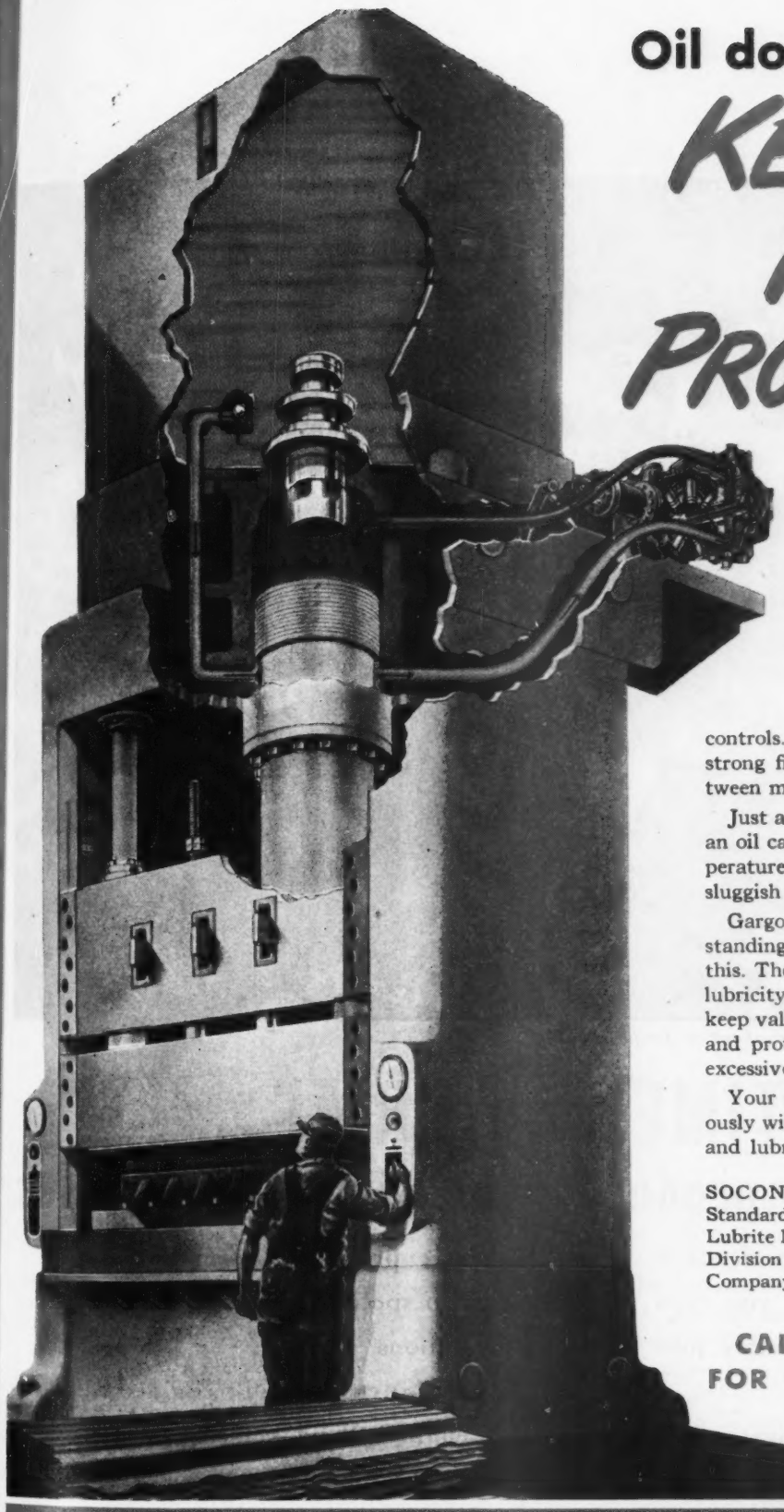
HERE is a remote reading flow rate meter with many unique and valuable features.

First of all, it has a new, patented electrical circuit and the transmission to the remote indicator is completely electrical—there is no stuffing box and *no friction* in the transmission system. . . . Second, it is based upon our rotameter as the prime flow rate measuring element so the calibration is a straight line and the electrical transmission reproduces this feature in the remote indicator, thus giving evenly spaced scale divisions. The high accuracy of the rotameter is ***fully retained*** in the remote indication, even at the lowest part of the flow range. . . . Third, the rotameter used for the prime flow rate measurement is our patented "Stabl-Vis" type which automatically compensates for variations in viscosity and density in the fluid being metered. Therefore, ***high reproducibility*** of the initial calibration is obtained regardless of flying conditions and in spite of normal differences in the composition of the fluid for which it is calibrated. . . . Fourth, the weight of the instrument containing all of these valuable features is only 6¼ pounds total for the meter and remote indicator.

This meter definitely improves the old standard of performance for remote indication of flow rate in airplanes and the news of its success is spreading like wildfire. You, too, may wish to consider it for your research and for incorporation into the specifications of a promulgated plane. We will be glad to have you write us concerning your flow rate problems and in reply will send you without obligation the full details regarding this new and better remote reading flow rate meter for aircraft.

FISCHER & PORTER COMPANY

301 COUNTY LINE ROAD · HATBORO · PA.



Oil does double-duty to KEEP THIS PRESS PRODUCING!

INSIDE big hydraulic presses like this, the right oil is doubly important. For here oil not only serves as the medium to transmit power, but also as the lubricant for vital moving parts.

As the hydraulic medium, this oil must possess great chemical stability to resist the formation of deposits that clog valves and interfere with controls. As the lubricant, the same oil must form strong films to resist high surface pressures between moving parts, particularly in the pump.

Just as important is correct oil body. Too light an oil can cause slippage, loss of power and temperature increases. Too heavy an oil can result in sluggish action, slow response to controls.

Gargoyle Oils, used in circulation systems, are standing up over long periods in machines like this. These oils combine great stability with high lubricity. They reduce deposits to a minimum, keep valves and oil lines free for sensitive control, and protect precision parts against friction and excessive wear.

Your machine stays on the job more continuously with less power loss and lower maintenance and lubrication costs.

SOCONY-VACUUM OIL COMPANY, INC., Standard Oil of N. Y. Division · White Star Division Lubrite Division · Chicago Division · White Eagle Division · Wadhams Division · Magnolia Petroleum Company · General Petroleum Corporation of Calif.

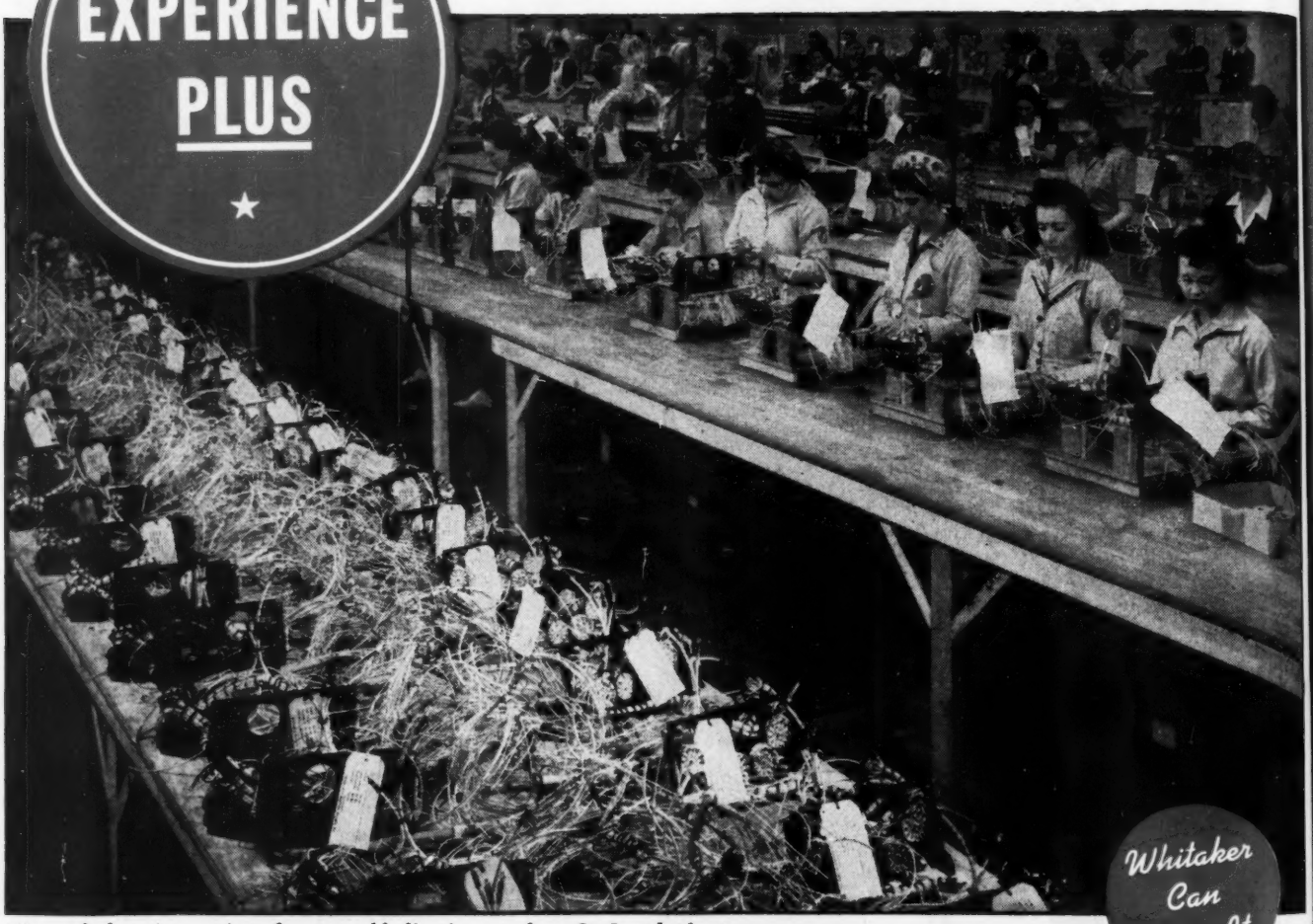
CALL IN SOCONY-VACUUM FOR "CORRECT LUBRICATION"

Socony-Vacuum's FIVE STEPS to Lower Production Costs for You

1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured

GARGOYLE Lubricants

EXPERIENCE PLUS



Pictured above is a section of an assembly line in one of our St. Joseph plants.

Whitaker Can Wire It

SAVE TIME and GRIEF

by having Whitaker produce your wiring assemblies

A quarter of a century of experience is made available to you when you turn your wiring harness and assembly jobs over to Whitaker.

You will find that the statement "Whitaker can wire it" is no idle boast . . . We have the experience, *plus* ample plant facilities for volume production . . . All Whitaker produced assemblies are engineered to specifications, and pass exacting inspections.

In addition to custom-built engineered wiring assemblies, Whitaker also offers a quality line of standard stock cable products . . . We cordially invite you to write and advise us of your needs.

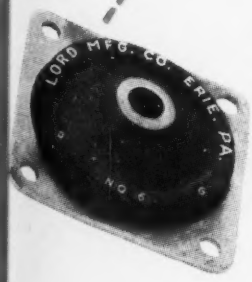
WHITAKER CABLE CORPORATION

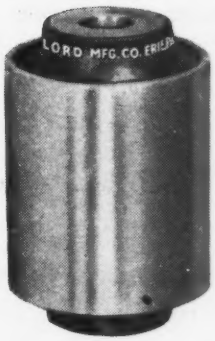
General Offices: 1301 Burlington Avenue, Kansas City 16, Missouri
Factories: Kansas City, Mo. • St. Joseph, Mo. • Philadelphia • Oakland

Cables, Wiring Harnesses and Assemblies for Automotive, Aircraft, Marine and Radio Equipment

The name **LORD**

On Mountings and other BONDED RUBBER Products Assures the Ultimate in Vibration Control





Every genuine Lord vibration mounting has the name "LORD" molded into the rubber section, as a means of ready identification, and as a guarantee to the user that he is receiving Lord quality.

Lord has had the best part of a generation of scientific research and experiment in the field of vibration. Lord processes and features, many of which are patented, have proven, in practically every field of industry, that they provide the highest degree of vibration isolation efficiency. Lord Mountings are bonded, rubber to metal, in a union that can't fail because the bond is as strong as the rubber. In every Lord Mounting, the size, the shape and composition of the rubber is accurately determined by the requirements of the job. In the process of manufacture, the rubber is put under no stress or tension, compression or torque, and is ready to give its full strength and resiliency to combatting the forces of vibration.

Included in this famous line of products are plate and tube form mountings, flexible couplings, engine suspensions, meter mountings and diaphragms. Special bonded-rubber products of every conceivable shape and size are produced to specification. All bear the name "LORD".

If you have a vibration problem, or a mechanical design problem involving the use of functional rubber, it may best be solved by means of rubber-bonded-to-metal. Call in a Lord Vibration Engineer, or write for literature on the subject. There is no obligation.

Do More Than Before—Buy EXTRA War Bonds

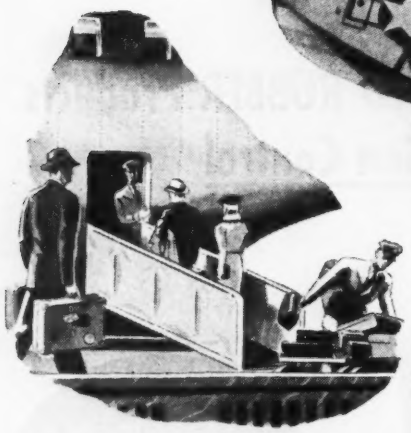
IT TAKES **BONDED RUBBER** *In Shear* TO ABSORB VIBRATION

LORD MANUFACTURING COMPANY
ERIE, PENNSYLVANIA

SALES REPRESENTATIVES
NEW YORK - - 280 MADISON AVE.
CHICAGO - 520 N. MICHIGAN AVE.
DETROIT - - 7310 WOODWARD AVE.
BURBANK, CAL. - 245 E. OLIVE AVE.
CANADIAN REPRESENTATIVES
RAILWAY & POWER ENGINEERING CORP., LTD.
TORONTO, CANADA

Originators of Shear Type Bonded Rubber Mountings

The Martin Mars Stands for Safety!



CLIMBING ON 2 ENGINES: Demonstrating it's high safety factor, the 72-ton Martin Mars gains altitude with 2 of it's propellers fully feathered.

WHO will be tomorrow's overocean airline passengers? Recent surveys tell us that 45 is the approximate age at which the greatest number of airline trips are taken. Thus it seems likely that the majority of tomorrow's overocean passengers will be successful business men and middle-aged tourists who have earned the time and money to travel abroad. Older, more conservative, they will probably be swayed by considerations of safety—will undoubtedly prefer flying boats, like the Martin *Mars*, for transocean air travel.

Mars Transports Stress Safety

As a flying boat, the *Mars* possesses greater inherent safety than landplanes for extended overocean trips. Then, too, its huge size and strength give the added assurance that if forced down it could cope successfully with heavy waves. More, it has demonstrated its ability to remain aloft on only 2 engines, its wings are sufficiently thick to permit the crew to service the engines while in flight, and the most modern safety devices of every sort have been incorporated in its design. In safety, as in payload and low operating cost, the Martin *Mars* is second to none!

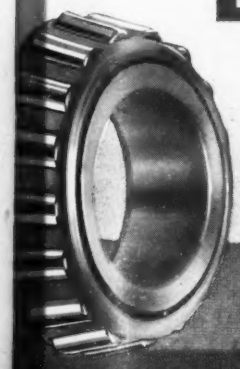
Tested and Proven in Service

Most important of all, the *Mars* has been tested and proven in regular transocean service with the Navy. All "bugs" have been ironed out, all findings have been incorporated in the 20 larger *Mars* transports now being built. As a result, war's end will find Martin production lines completely tooled and manned for prompt delivery of these ultra-dependable aircraft. *Airlines and shipping companies interested in information on commercial versions of the Mars,* write: THE GLENN L. MARTIN CO., BALTIMORE 3, MARYLAND

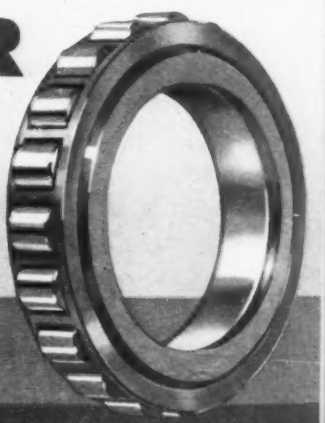
Martin
AIRCRAFT

Builders of Dependable Aircraft Since 1909

BOWER CARRIES THE POWER



In every major type of automotive equipment you will find the power load carried by some type of Bower Roller Bearing engineered to reduce friction to the very minimum at every point on the power line.



BOWER
ROLLER BEARING CO.
Detroit, Michigan

● On nine Societe Genevoise Boring Mills, paragons of precision and mechanical perfection, Allied's master craftsmen maintain a single standard of excellence. This same unfaltering skill and superior equipment extend to every department.

Buy More War Bonds

A Single Standard of Excellence

Your postwar products deserve the same thoroughgoing craftsmanship and unerring precision that Allied is building into products for war.

Even before the first World War, the divisions of Allied were famous for their inflexible single standard of excellence and meticulous workmanship. Over the years, R-B interchangeable punches, Allied sheet metal dies, steam-heated plastic molds, special tools and cold forged parts have found their way into nearly every mass production industry. In this war Allied has produced countless thousands of hardened and precision ground parts; many for airplane engines and guns which are machined to within limits of two ten-thousandths of an inch.

Soon Allied's enlarged and improved facilities will b turned to production for peace. If you are looking fo a dependable, economical source of supply you can u Allied's "Pool of Precision". Write today.

• • •

"IT'S AN ALLIED PRODUCT" . . . Allied Products Corporation and its divisio Richard Brothers and Victor-Peninsular, in Detroit and Hillsdale, Michig also make: Jigs and fixtures, cold forged parts, cap screws and other speci machines and products.

ALLIED PRODUCTS

C O R P O R A T I O N

Department 17, 4614 Lawton Avenue, Detroit 8, Michig

At Last

a standard marking system for grinding wheels

Quick, easy, understandable information on everything anyone needs for specifying, buying and using grinding wheels features this new Standard Marking System. Devised and adopted by the Grinding Wheel Manufacturers Association, it will be Standard for all manufacturers.

For the convenience of customers, until the new uniform system becomes universal, Abrasive Company wheels will bear two markings — one according to the old system, one according to the new.

Users are cautioned that while *wheels of different makers may be marked alike, they will not necessarily grind alike.* In selecting wheels therefore, it is always advisable to consult the Abrasive Company's Grinding Wheel Data Book Supplement which lists General Recommendations, using the New Marking System, for a wide range of materials and jobs.

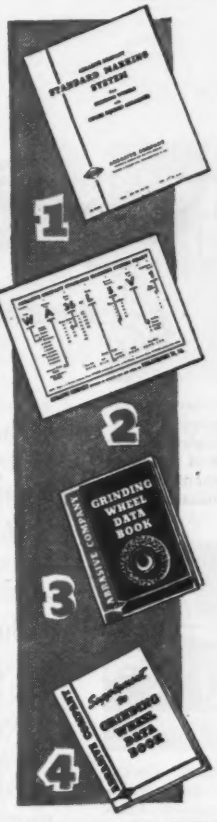
The Abrasive Company Diamond Trade-Mark on any Borolon (aluminum oxide) or Electrolon (silicon carbide) Wheel is assurance of accurately controlled manufacture according to specifications indicated by the Marking. Performance in use is demonstration of Abrasive Company outstanding quality.

abrasive Company

Abrasive Company, Philadelphia 37, Pa.
Division of Simonds Saw and Steel Company

DISTRIBUTORS IN ALL PRINCIPAL CITIES

SEND FOR THESE NEW ABRASIVE COMPANY GUIDES TO THE NEW MARKING SYSTEM



1. This folder describing and illustrating the New Standard Marking System and showing how it differs from Abrasive Company's former system should be in the hands of every buyer and user.

2. This handy simple chart for desk or wall provides ready reference to the New Standard Marking System. Get one for everyone in your plant who is concerned with Grinding Wheels.

3. This Abrasive Company 120 page GRINDING WHEEL DATA BOOK is an authentic manual. Complete descriptive data on the use and application of grinding wheels and other Abrasive Company Products.

4. This new supplement to the GRINDING WHEEL DATA BOOK contains wheel selection table giving general grain and grade recommendations according to the New Standard Marking System for 177 grinding classifications.

CLIP COUPON AND MAIL

ABRASIVE COMPANY, PHILADELPHIA 37, PA.

Please send Guides to New Marking System as follows:

No. 1 ☐ No. 2 ☐ No. 3 ☐ No. 4 ☐

NAME_____

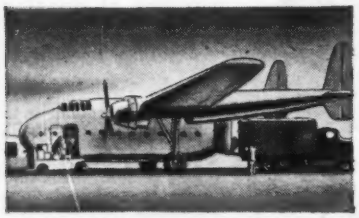
ADDRESS_____

FAIRCHILD ANNOUNCES

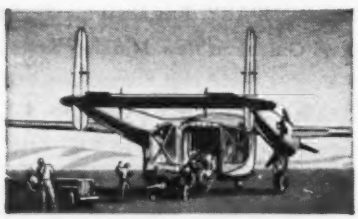
The PACKET

FOR AIR CARGO

THIS FLYING BOXCAR in military operation can carry 42 fully equipped paratroops and deliver them through *two* rear end jump doors at either side of the huge fuselage. Paracans of equipment are released through bomb bay doors beneath the plane.



LOADING MADE EASY, another Packet feature. A huge split door in the stern, a smaller freight door forward simplify loading and unloading of cargo. The cargo floor parallels the ground *at loading truck floor level* eliminating the need for hoisting devices.



OVER 3,500 MILE RANGE means speedy delivery of vitally needed supplies in military operations—cargoes measured, not in pounds, but in *tons*. Today, for the Army; tomorrow, it's yours!

The PACKET is designed *specifically* to transport cargo and troops by air...to carry boxcar loads at air express speed. It was born of a wartime need. The Army presented the problem to Fairchild engineers:

Build a plane that can utilize average airports and fly long or short distances economically—a plane with huge cargo capacity, for men, guns, trucks, ammunition or equipment.

Such a plane is The PACKET. It is in the air today, the first of many to undergo rigid flight tests. An all-metal, high-wing monoplane, The PACKET is powered by two 2100-horsepower engines. It is designed to operate with the simplicity and economy of twin-engine airplanes.

Fairchild engineering experience has given The PACKET another invaluable quality. While today it can carry the weapons of war, tomorrow, with but minor modification, it can transport the goods of peacetime commerce.

It has the characteristic inherent in all Fairchild products—the "touch of tomorrow in the planes of today."

BUY U. S. WAR BONDS AND STAMPS

Fairchild Aircraft

Division of Fairchild Engine & Airplane Corporation, Hagerstown, Maryland

Don't Handicap Important Designs

for Lack of a SMALL Electric Switch

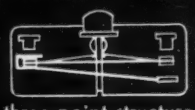
3 basic contact arrangements

single-circuit, normally open

single-circuit, normally closed

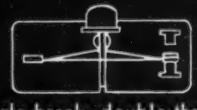
double-circuit; one normally open and one normally closed

And many special forms. For example:



three-point structure

single-break, normally open



single-break, double-throw

THE G-E SWITCHETTE IS ONLY THIS BIG

(This one is ACTUAL SIZE)

WHEREVER you need a tiny contact mechanism in ratings up to 10 amperes at 24 volts d-c—an enclosed, self-contained unit that's light and compact, yet can withstand thousands of operations—there's a G-E Switchette to do the job.

This tiny switch weighs only 9 grams, and is suitable for use at altitudes up to 50,000 feet and in ambient temperatures from 200 F to −70 F. It's corrosion-proof—meets 50-hour salt-spray tests. It's vibration-resistant. The contacts will not chatter when subjected to mechanical frequencies of 5 to 55 cycles per second at 1/32-inch maximum amplitude (1/16-inch total travel), or to a linear acceleration of 25 g in any direction.

Two terminal arrangements are available—out the ends of the case as shown above, or out the top through the cover. This makes for easy mounting in any position.

More than 200 design modifications of the G-E Switchette are available to provide for a wide variety of electrical and mechanical arrangements.

SHIPMENT FROM STOCK

Some forms are now available from warehouse stocks in substantial quantities, to give you quick delivery for your important war jobs.

For your copy of our new catalog (GEA-3818B) which gives dimensions, ratings, and ordering directions for both standard and modified Switchettes, call our local office. *General Electric Co., Schenectady 5, New York.*

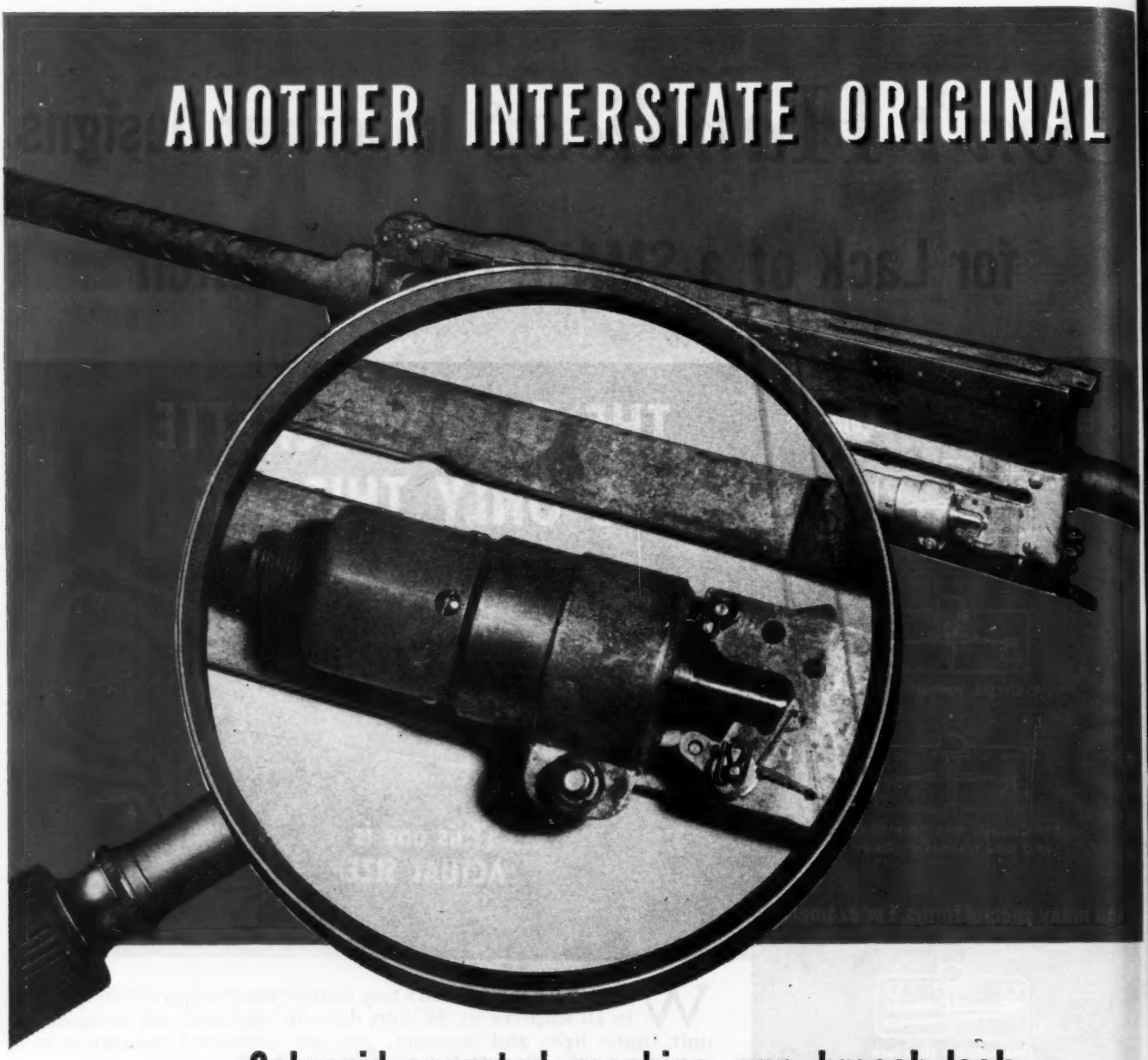
SWITCHETTES

GENERAL ELECTRIC

676-140-8940

BUY WAR BONDS

ANOTHER INTERSTATE ORIGINAL



Solenoid-operated machine gun breech-lock

This device—originated by Interstate engineers—is adaptable to guns with Interstate Chargers or with other chargers. The breech lock operates every time a bullet is fired—at the lightning-rate of 2,000 a minute. It automatically locks when the trigger is released—holding the gun in locked position until it is fired again.

For detailed information about this and other Interstate Precision Units, address Sales Department—

Interstate

AIRCRAFT AND ENGINEERING CORPORATION • EL SEGUNDO, CALIFORNIA

SPECIFY CURTIS

Universal joints play an important part in the operation of airplanes and machine tools.

Where out-of-line transmission of power, or rotation of shafting around corners or at angles is necessary — strains and wear on universal joints working at such angles are excessive.

Engine controls—retractable landing gear—auxiliary power controls and elevator spars must have smooth, positive operation for the pilot and his crew.

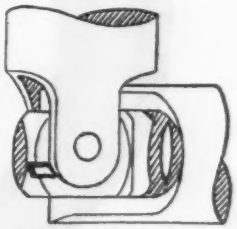
In machine tools too — failure of any part means loss of production and costly repair shutdowns of multiple drill presses, grinders, milling machines, etc.

Curtis Universal Joints, made to Curtis "Standards" have PROVED their ability to "take it." The rigid Army Air Corps Class 1 specifications for strength and toughness are met and surpassed by Curtis Joints.

Through years of experience Curtis applied special steels and developed proper heat treatments to secure maximum strength and toughness. Accurate machining and fitting to close tolerances gives smooth, free-working surfaces — Curtis oilers insure proper lubrication — and the patented "Telltale" lock ring tells at a glance that each part is firmly locked together and permits rapid disassembly and reassembly in the field.

All these plus magnaflux inspection by certified operators give Quality Control thruout production.

Specify Curtis Universal Joints in any of their 14 sizes — let Curtis Engineers work with you on your problems — be sure of "Proven Performance."

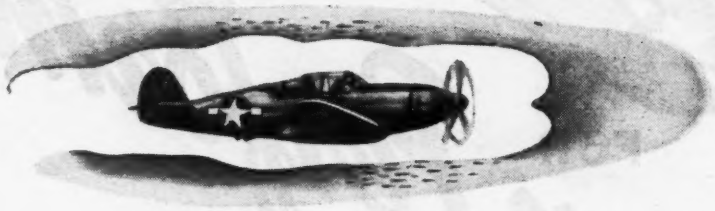


NOTE: End of Curtis patented "Telltale" lock ring is readily visible —showing that joint is securely locked together.

CURTIS UNIVERSAL JOINT CO. INC.

SPRINGFIELD, MASS. • BOSTON GEAR WORKS, NO. QUINCY, MASS., SOLE DISTRIBUTORS

HOW
Flex-O-Tubes
SERVE IN THE AIR

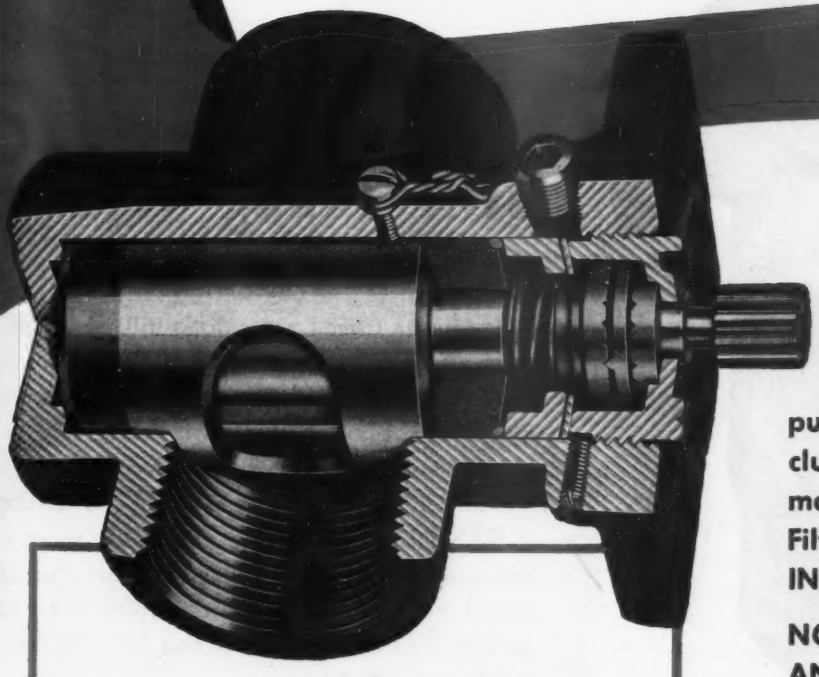


AUTOMATIC PILOT ACTUATION
BOMB DOOR CONTROLS
CONTROL SURFACE BOOSTER
COWL FLAP CONTROLS
DE-ICER HOSE
FUEL AND OIL LINES
GUN MOUNT CONTROLS
HYDRAULIC BRAKES
HYDRAULIC GUN CHARGER
HYDRAULIC GUN TURRETS
HYDRAULIC RUDDER CONTROLS
HYDROMATIC PROPELLER CONTROLS
INSTRUMENT LINES
OXYGEN FEED LINES
PUMP CONNECTORS
RETRACTABLE LANDING GEAR
RETRACTABLE LANDING LIGHTS
RETRACTABLE NOSE WHEEL
RETRACTABLE TAIL WHEEL

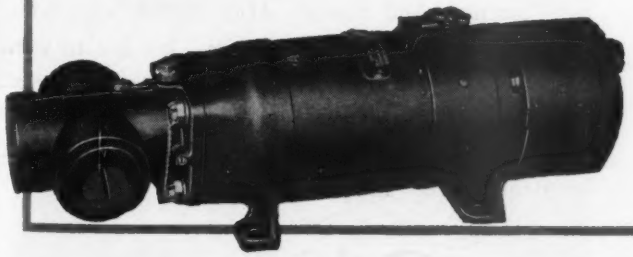
THE **Flex-O-Tube** COMPANY

LAFAYETTE at 14th AVE.,
DETROIT 16, MICHIGAN
Offices: CHICAGO · FORT WORTH
LOS ANGELES · NEW YORK
SEATTLE · TORONTO, ONT.

Do you know
THE PUMP ON THE SUPER-FORTRESS?



Rated capacity, 900 G.P.H. at 27.5 volts, 14" Hg discharge pressure, 8" Hg inlet suction, 14.5 Amps. Max. Both ports are tapped 1¼" N.P.T.



• You are looking at a photo of a ¾ cutaway view of ROMEC RD-5530 pump used on electric driven transfer pumping unit RD-6100. This unit includes the transfer pump, the G.E. motor and the Sprague Radio Noise Filter. This Unit is used on the BOEING SUPER-FORTRESS B-29.

NON-CORROSIVE THROUGHOUT AND NOT AFFECTED BY EXTREME TEMPERATURES. Motor is reversible, continuous duty, shunt wound and explosion-proof type. Rated .28 H.P. at 2500 R.P.M. and 24 volts D.C. Complete unit weighs only 13 lbs., 12 ozs. If you want a fuel transfer pump that is unexcelled in manufacturing precision, performance, and reliability, write or wire for details on this RD-6100 unit today.

Romec PUMP COMPANY

117 ABBE ROAD • ELYRIA, OHIO, U. S. A.

Still Young at 99..

Who wants a tracing paper that's still good—and we mean *good*—still white, transparent, flexible—99 years later? Well, you can never tell. Maybe more tragic things have happened than having a drawing go to ruin in its sleep, but nevertheless, that can be awfully serious. That's only one reason why we developed ALBANENE white tracing paper. It's permanent, because it's made of 100% long-fibre pure white rags, treated with Albanite. In drafting rooms today there are drawings on ALBANENE that are years old and still in perfect condition.

What's Albanite? It's a crystal-clear, unaltering synthetic developed by the K&E Laboratories, and is simply tops as an impregnating medium for long-fibre paper stock. That gives ALBANENE extra transparency. And because ALBANENE stays white, it gives strong, contrasting prints. It's fine to work on too, with pencil or ink—keeps clean and takes erasures well. That's not the whole story; to get it all, write us on your letterhead for a sample sheet. Made in rolls, sheets, and pads.

K&E

Drafting, Reproduction, Surveying Equipment and Materials
Slide Rules, Measuring Tapes

Albanene

REG. U. S. PAT. OFF.

KEUFFEL & ESSER CO.
EST. 1867

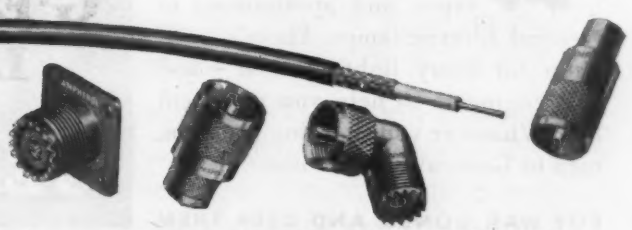
NEW YORK • HOBOKEN, N. J.
CHICAGO • DETROIT • ST. LOUIS
SAN FRANCISCO • LOS ANGELES • MONTREAL

Equipped to Surmount NEW PEACETIME PEAKS

● Up to 1940 when war construction began, Amphenol had a long, proud record of achievement in the production of electrical transmission equipment of the better—more critical—kind. Among other "firsts" Amphenol had developed, and built, the first ultra-high frequency cable.

When production for the Air Corps, Army and Navy demanded precision far beyond that of civilian manufacture, Amphenol went to work exclusively for the Armed Forces . . . will continue working for Uncle Sam until the last bomb burst. When that time comes, the years of experience "under fire", the broadened perspective and knowledge will mean new and improved products, a source of supply of unlimited capacity. This is a rich background of experience in the production of parts for the users of electrical transmission equipment in the electronic, radio and electrical fields.

Depend upon AMPHENOL *Quality*



AMERICAN PHENOLIC CORPORATION, Chicago 50, Illinois • *In Canada:* Amphenol Limited, Toronto

Connectors (AN, British, U. H. F.) • Conduits • Fittings • Cable Assemblies • U. H. F. Cables • Radio Parts • Plastics for Industry

SEE how G-E lamps helped step up plant output 25%

PROBLEM: Adequate footcandles were already available on this job . . . but glaring, eye-straining light from improperly located fixtures made seeing difficult and production lagged.

ANSWER: Relocation of fixtures—worked out by G-E Engineers—eliminated glare, helped workers see better, faster, more accurately . . . and stepped up over-all lighting performance.

RESULTS: After all lamps were installed and turned on, high level illumination (150 footcandles on surface of machines) gave comfortable lighting . . . and vastly improved working conditions for machine operators.

Here's a Lighting Job That Reduces Costs, Saves Time and Increases Critical Wire Production

Better light, controlled and at work, has licked hundreds of tough production problems—and with highly profitable results.

Take this super-essential plant making extremely fine enamel-insulated wire, for example. It requires quick and positive visibility to detect breakage and keep up steady production of fine wire that varies from .0008 to .0025 inch in diameter. As the wire spins off the spools, through the enamel bath, into the bake oven, and out onto the finished spools, production must move in a steady, uninterrupted flow to keep on schedule.

Now—thanks to relighting by G-E Engineers—workers see *better.* They spot costly breakage *faster.* And wire output is up 25 per cent!

WHAT'S YOUR PROBLEM?

There's hardly any limit to the many practical uses, types, and applications of General Electric lamps. There's a G-E lamp for every lighting need — and G-E engineers to help you use them best. Whatever your lighting problem, turn to General Electric *now!*

BUY WAR BONDS AND KEEP THEM

"To Make G-E Lamps STAY BRIGHTER LONGER"
The Constant Aim of G-E Lamp Research

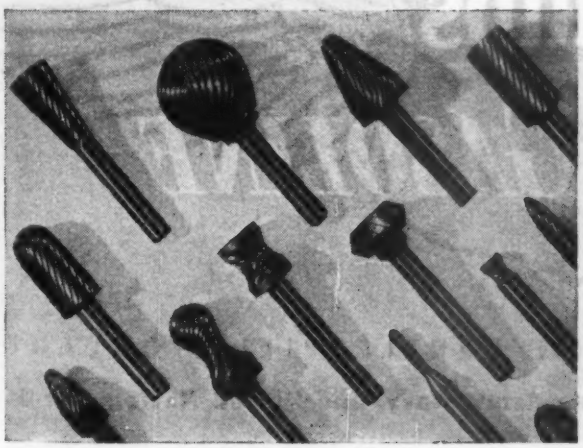
G-E MAZDA LAMPS

GENERAL ELECTRIC

SEVERANCE MIDGET MILLING CUTTER GIVES PERFECT FINISH INSIDE INTRICATE CASTING

CUTAWAY VIEW OF ROUGH CASTING SHOWING FLASH EDGE AT INACCESSIBLE POINT
CUTAWAY VIEW OF FINISHED CASTING WITH FEATHERED EDGE REMOVED BY SEVERANCE CUTTER

No matter what your finishing requirements may be, there is a Severance Midget milling cutter made to fit your needs.
Severance regrinding service saves you time and money.
Severance complete line of "Carbide" midget milling cutters are now available.



Every day manufacturers are discovering new and important applications for Severance Midget Milling Cutters. Take, for example, the aluminum elbow you see here. At the bend, on the inside of the casting is a flash which ordinarily would present a finishing problem. But with a Severance Special Ball cutter, this hard-to-get-at ridge is quickly and perfectly removed.

Severance Midget Milling Cutters are efficiently finishing castings, parts and patterns made of metals, alloys, plastics and wood. With portable power tool, with stationary set-up or by hand, Severance Cutters do the finishing job cleaner, faster and easier.

If you wish to speed up your finishing of manufactured parts send us samples. Our engineers will help you determine the kind of cutter best fitted to your needs.

Severance

MIDGET MILLING CUTTERS • PRECISION REGRINDING
SEVERANCE TOOL INDUSTRIES INC., SAGINAW, MICH. •
PLANTS IN LONG ISLAND CITY, N.Y.; DETROIT, MICH.;
FORT WAYNE, IND.; CHICAGO; AND LOS ANGELES

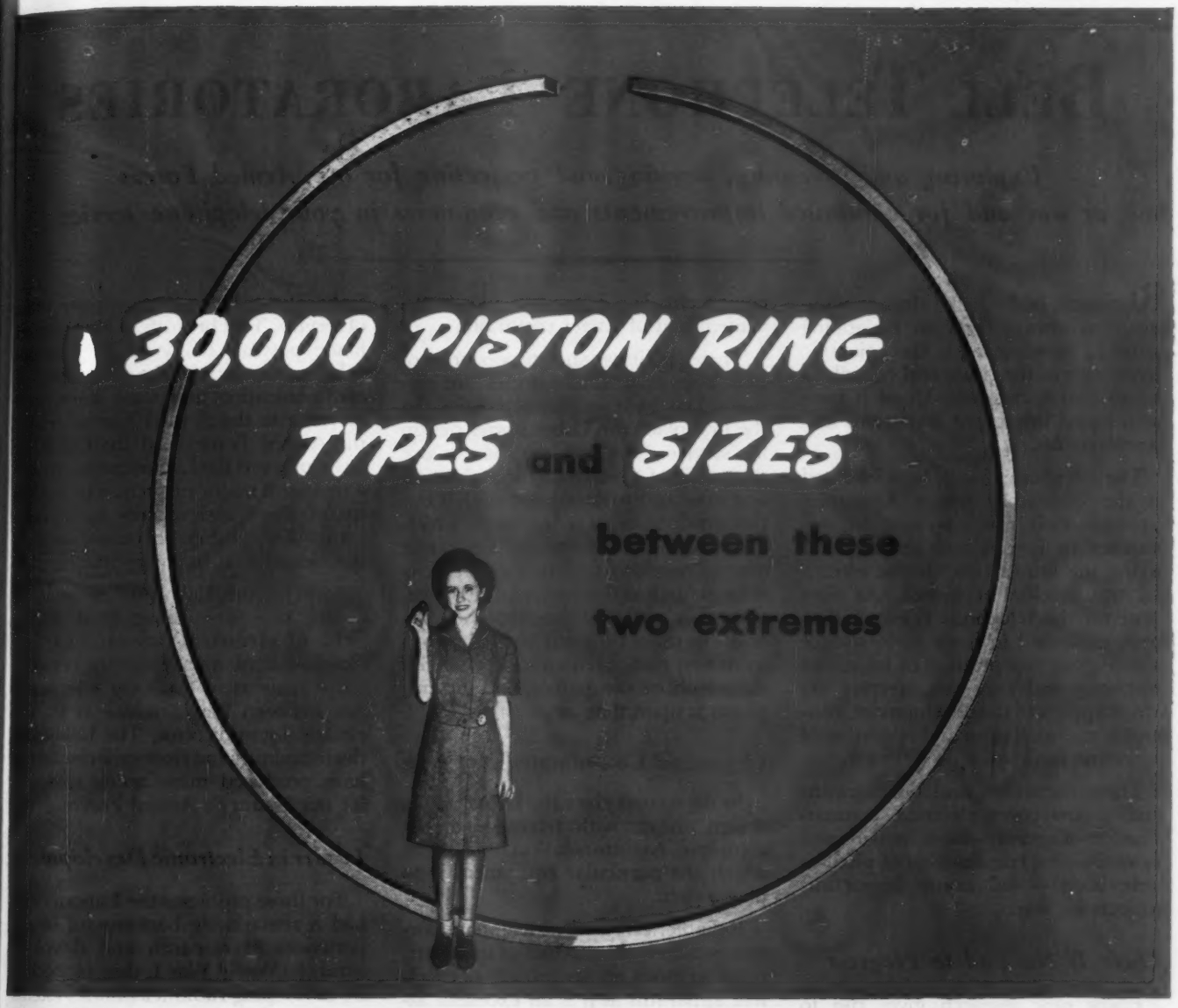
Phillips---

great wartime record
in the production of
100-octane gasoline

perfects
our peacetime record
and foretells

finer postwar fuels

Phillips
AVIATION GASOLINE



The smallest piston ring we make (you couldn't get it on your little finger) is used in the watch-like mechanism of the torpedoes that are helping to snip Japan's lifeline.

The largest piston ring we make (it's over 30 feet around) has done and is doing duty on over three-fourths of the Liberty ships whose wakes are writing V's for Victory all over the Seven Seas.

And in between these two extremes are 30,000 other types and sizes of piston rings—*for which we have patterns in our foundry.* This tremendous range of ring patterns, always available, made American Hammered a unique source of supply for the most diversified requirements.

Another important service asset is know-how . . . and that has been strikingly expanded during the war years. The PORUS-KROME* treatment that increases the life of piston rings two—three—and even four times, and the new alloy rings with double the tensile strength of any pre-war product, will let you demand more from your piston rings . . . and get it.

Rings in every size—of every type—for every purpose make this the best place to bring your ring problems. Koppers Co., Inc.—American Hammered Piston Ring Division, Baltimore 3, Md.

*Van Der Horst Process

Buy Extra War Bonds—and Keep Them!

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for our Armed Forces at war and for continued improvements and economies in your telephone service

RESEARCH, in the Bell Telephone System, has always been an expanding activity, growing with the scientific knowledge of the times and contributing to that knowledge. Upon it have been based important inventions and developments.

The telephone, itself, was invented in the laboratory where Alexander Graham Bell was carrying on researches in speech and hearing and laying the foundation for the electrical transmission of speech. As time went on the telephone research program expanded to cover every science which gives any promise of improved telephony and every engineering art which applies to the development, construction, installation and operation of telephone facilities.

These researches and development studies now cover electrical communication of speech—both by wire and by radio—the transmission of pictures (television)—and many important projects for war.

There Is No End to Progress

Every new research gives rise to new inventions and to new lines for development and design. New inventions indicate new lines for more research. Research and development work, invention and design go hand in hand. In the early years, this work was carried in part by the American Telephone and Telegraph Company and in part by the Western Electric Company, the manufacturing unit of the Bell System.

For many years, however, this work has been assigned to a specialized unit, Bell Telephone Laboratories, Incorporated. Theirs is the responsibility for the technical future of the industry. They carry their developments from the first faint glimmerings which basic researches disclose to the final design of equipment and the preparation of specifications for its manufacture. And after manufacture and installation, they follow their products in operation; and continue development work to devise still more perfect equipment, less expensive, more convenient and of longer useful life.

These policies and procedures of Bell Telephone Laboratories are distinguished by two characteristics. In the first place the Laboratories design for service. The consideration is not the profit of a manufacturer through first sales and replacement models but the production of equipment which will give the best service at the lowest annual cost when all factors are considered, such as first cost, maintenance, operation, and obsolescence. The Laboratories make no profit and the equipment they design is owned and used by the telephone companies; and the emphasis is upon that use.

Organized Co-ordinated Research

In the second place the Laboratories design always with reference to the complete communication system in which the particular equipment is to play a part.

Reliable, economical telephone service, which is the product of its efforts, is not so much an assemblage of excellent apparatus as it is an excellent assembly of co-ordinated equipment—all designed to work together reliably and economically for a larger purpose.

It is not enough that Bell Laboratories shall design a new piece of electronic equipment which has merit or a new cable or telephone receiver. They must design with reference to all the other parts of the communication system so that the co-ordinated whole will give the best possible service.

4600 People in Bell Laboratories

Bell Laboratories contributions to the Armed Forces derived in large part from the technical background that the Laboratories had acquired through their steadily maintained program of research. The Laboratories had special knowledge, skill and techniques which could instantly be diverted to war problems.

At the time of Pearl Harbor, over a quarter of the 4600 people in the Laboratories had twenty or more years of service. This breadth of background made possible many engineering developments outside the strict field of communication and these have been of value to the Armed Forces. So far the Armed Forces and the O.S.R.D. have engaged the Laboratories on over a thousand major projects. The majority of these assignments have been completed; and have contributed to our victories on many fronts.

Most of the Laboratories developments, of course, have been in the field of electrical communication. Communication, not simply between individuals as in ordinary telephony, but between mechanisms—as in the electrical gun director. The Laboratories techniques and electronic researches have produced many secret weapons for our country's Armed Forces.

Leader in Electronic Development

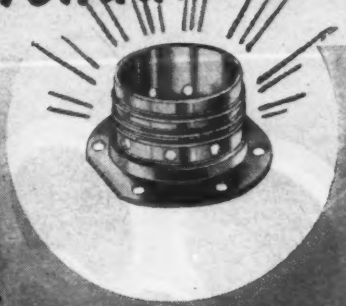
For those problems the Laboratories had a remarkable background of experiences in research and development. In World War I, they pioneered by developing radio telephone systems for talking between planes and between planes and ground stations. They also contributed methods and devices for locating enemy planes, submarines, and artillery.

In this war, Bell Laboratories have pioneered in the field of electronics. The Western Electric Company, which manufactures the designs of the Laboratories, is the largest producer of electronic and other war communication equipment in the United States and is now engaged almost exclusively in the manufacture of this equipment.

In war, Bell Telephone Laboratories devote their work to the needs of our Armed Forces. In peace, they are constantly exploring and inventing, devising and perfecting for continued improvements and economies in telephone service. Centralized research is one of the reasons this country has always had "the most telephone service and the best at the least cost to the public."

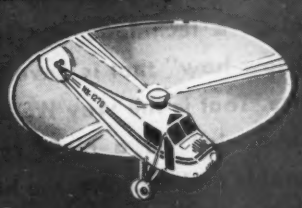
BELL TELEPHONE LABORATORIES

"It sounds to me like a job for Aeronautical Products, Inc."



WHAT KIND of precision parts does *your* post-war job require? Automatic screw machine . . . grinding . . . thread grinding . . . thread milling . . . superfinishing . . . hyprolapping . . . heat treating . . . nitriding . . . plating . . . magnafluxing . . . tolerances as low as .0001? The point is this: If your assemblies require the machining of parts to hair-breadth limits, we're equipped to do the job faster . . . better! In one organization with two great plants, ALL the facilities ANY job requires.

AND THAT'S NOT ALL! With a solid foundation built on the top-speed production of precision units for aircraft engines long before Pearl Harbor, plus 100% war output, it stands to reason we'll retain our leadership after the war is won! If *you* have a post-war problem, consult "Precision Pacesetters", with a *record of accomplishment!* Want ideas? Engineering help? Costs? Write our Executive Sales Offices for complete list of equipment and facilities.



● THE SUCCESS of The Aeronautical Products, Inc. Helicopter, designed and built by our own craftsmen, promises new accomplishments in the post-war age of flight!

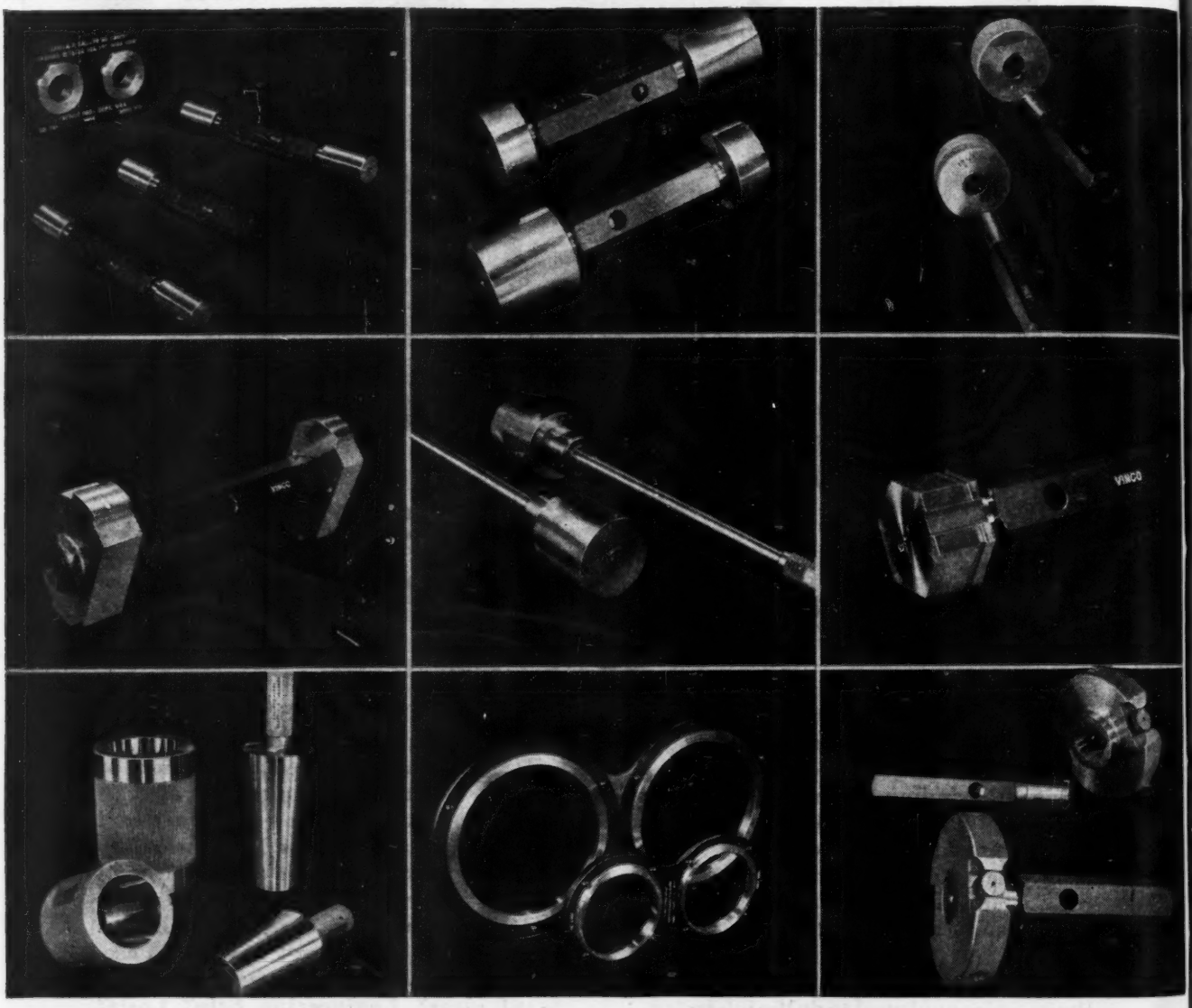
AERONAUTICAL PRODUCTS, Inc.

DETROIT PLANT
and Administrative Offices:
18100 Ryan Road, Detroit 12

API

OHIO PLANT:
Washington Court House
Ohio

PLAIN GAGES—BUT OF VINCO QUALITY



Simplicity of design plus a great demand have encouraged many gage shops to bid for this type of gage work without having sufficient skill and knowledge to produce the perfection required for constant, accurate gaging. A plain cylindrical gage must not only be accurate but have a hard, durable surface, smooth enough to satisfy the microscopic scrutiny of the surface analyzer. To grind the plug blank down to the required size and still maintain enough lap stock so the minute grind ridges can be lapped to this required smoothness involves a technique that is not learned over-night, a "know-how" that is developed only after long experience. That is the way *WE* make them—so if you are in the market for a plain cylindrical plug that is both durable and accurate, the best suggestion we can make is—Buy VINCO.

VINCO CORPORATION, 8865 SCHAEFER HIGHWAY, DETROIT 27, MICHIGAN. SALES OFFICES: NEW YORK, CHICAGO, CLEVELAND

MILLIONTHS OF AN INCH FOR SALE BY VINCO

REG. U. S. PAT. OFF.

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Hub Gages • Built-up and Special Gages • Gear Rolling Fixtures • Spline and Index Fixtures • Hydraulic Power, Control, Utilization and Distribution Units • Engineering, Design and Development.

FIBRE LOCKING PLUGS

FIG. 1

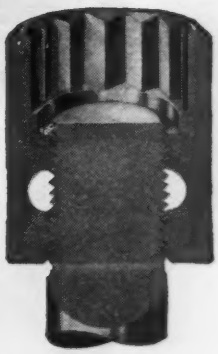
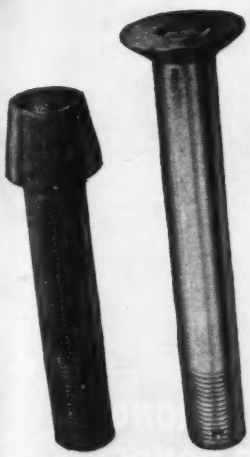


FIG. 2

SAFETY WITH UNBRAKO

Reg. U. S. Pat. Off.

INTERNAL WRENCHING LOCK NUTS



Our Internal Wrenching Bolt (B) and 100° Flush-Head Socket Bolt (C) were designed expressly by and for the aviation industry. These must be made to tolerances so extremely close as only our long and extensive experience in the field of precision automatic work makes practicable. The internal wrenching feature facilitates compact designs —Saves weight, material and cost.

For primary connections in aircraft, the "UNBRAKO" INTERNAL WRENCHING LOCK NUT is a superb and officially approved safety nut. Two vulcanized fibre plugs (Fig. 1) inserted through the body of the nut provide the locking feature. Fig. 2 shows how these plugs contact four threads of the bolt, assuring an absolutely dependable locking grip.

This design also permits of maximum thread length in the nut. "Unbrako" is heat treated to a high degree of Rockwell hardness. The "Unbrako" can be used again and again almost indefinitely before the torque falls below the Wright Field minimum.

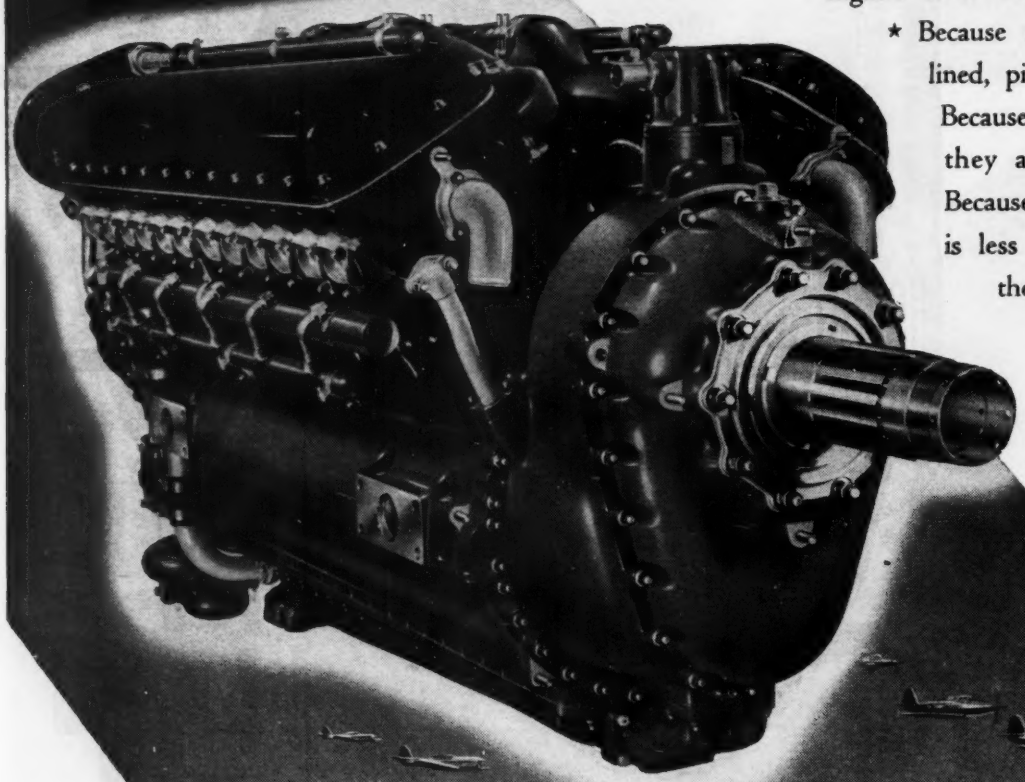
OVER 40 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA., BOX 566. BRANCHES: BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO

DISTINGUISHED SERVICE

Everywhere they have performed distinguished service — powered the craft of valiant flyers as they won coveted decorations. ★ They've blasted Germans and Japs, and have served the Russians and British. ★ They've been America's own liquid-cooled aircraft engines since long before Pearl Harbor. ★ Because these engines are streamlined, pilots have better visibility. Because of their dependability, they are always ready to go. Because of their smoothness, there is less pilot fatigue. Because of their economy with fuel, their range is wide. ★ These are engine qualities that will be important to you in the days of far-flung air transport to come.



POWERED BY ALLISON

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
A-36 and P-51—Mustang
P-63—Kingcobra

Allison has already furnished more than 75,000,000 H.P. for use in these planes.

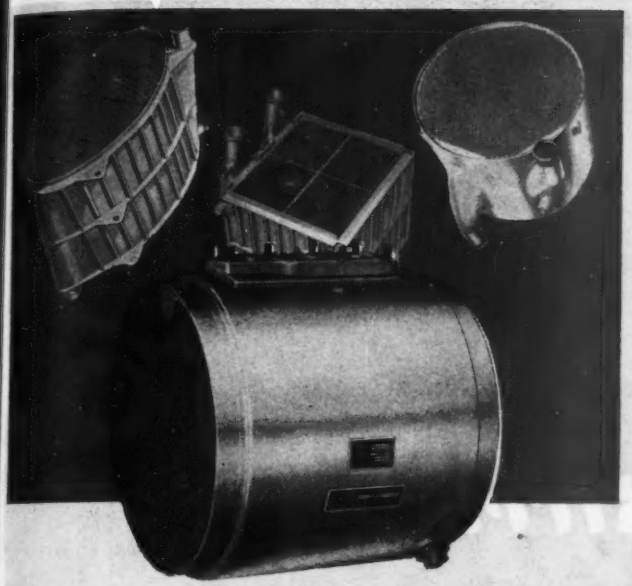
LIQUID-COOLED AIRCRAFT ENGINES

Allison
DIVISION OF
Indianapolis, Ind.

GM
GENERAL MOTORS

KEEP AMERICA STRONG
BUY MORE WAR BONDS

Every Sunday Afternoon
GENERAL MOTORS SYMPHONY OF THE AIR—*NBC Network*



ALUMINUM BRAZING VS. SOFT SOLDER

A heat transfer unit is only as strong as the bond that fastens its tubes to header plates or shell. The soft solder used for sweating copper units is low in resistance to temperature, pressure, vibration and shear. Silver solder or other high-melting-point solders can't be used because they anneal and weaken the copper at the soldering point.

ADVANTAGES OF ALUMINUM BRAZING

Clifford's discovery of the long-sought method of brazing thin-walled aluminum tubes brought four recognized advantages to heat-transfer engineers of the USAAF.

1. A saving of ⅔ the weight of copper in the same size and shape.
2. Heat-treatable aluminum tubes that don't break down under working temperatures as high as 275°F. instead of copper tubes that gradually anneal and weaken.
3. Heat-treatable aluminum alloy header plates, shells and other parts that stand up under much higher temperatures and pressures than other metals commonly used in heat transfer units.
4. An aluminum alloy bonding material capable of withstanding temperatures, pressures and strains several times higher than soft solder's limits.

Performance records of Clifford Feather-Weight Oil Coolers and Coolant Radiators in several types of USAAF fighters verify these advantages.

POSTWAR APPLICATIONS

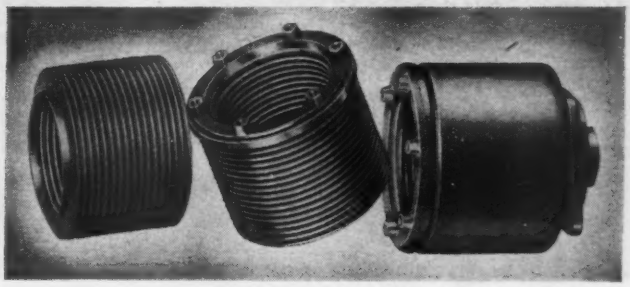
Although Clifford's production is now 100% in war work, inquiries and suggestions about postwar applications of all-aluminum heat-transfer units to automotive, heating, cooling and ventilating fields will be given full consideration. *Save ⅔ the weight . . . same size and shape.* Clifford Manufacturing Co., 562 E. First St., Boston 27, Massachusetts.

IN HYDRAULICALLY-FORMED BELLOWS only the fittest survive

Of all the tests Hydron Bellows must pass before they go to work for you, the first is the most severe. That's the test of the manufacturing process that gives them shape . . . hydraulic forming.

Figure it out for yourself. Take a paper-thin metal tube. Force the walls transversely between the plates of a collapsible die *under internal hydraulic pressure amounting to several hundred pounds per square inch.* Tubes with imperfections or flaws can't take it. They are automatically rejected by the process.

That's why every Hydron Bellows is a perfect metallurgical specimen . . . with no seams, tool marks or hidden flaws. And, further, that's why each Hydron Bellows has plenty of flexes left in its system when less severely tested bellows have quit on the job.



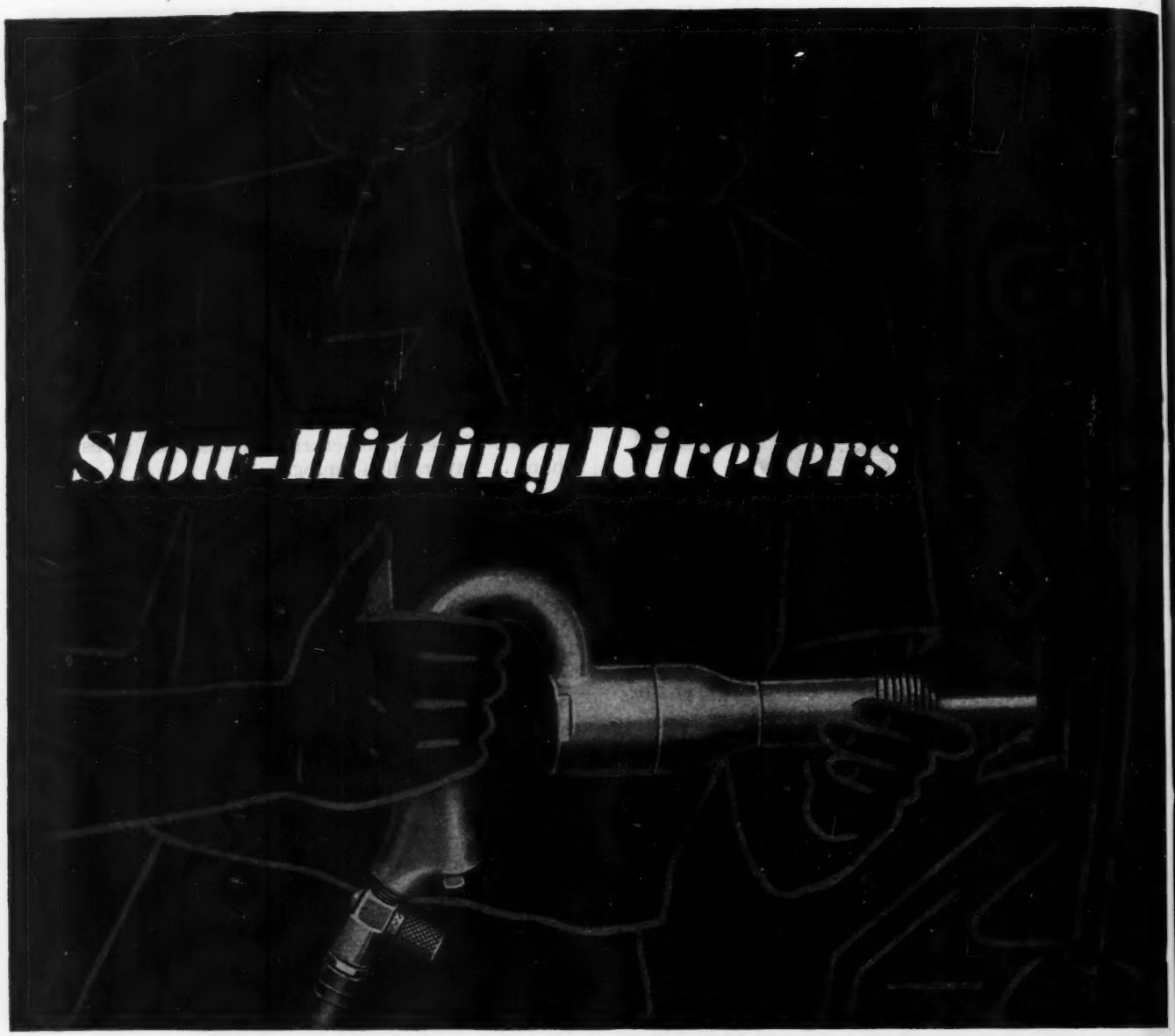
Naturally, when Clifford builds these perfect Hydron Bellows into assemblies for temperature and pressure control or for shaft seals and other exacting uses, every precaution is taken to preserve that inborn perfection.

Because the same men who produced industry's first hydraulically-formed bellows — Hydron — are still on the job, Clifford is equipped, perhaps better than anyone else, to supply you with these uniform, pretested hydraulically-formed bellows either as such or in highly-engineered bellows assemblies. *First with the Facts on Hydraulically-Formed Bellows.* Clifford Manufacturing Co., 562 E. First St., Boston 27, Massachusetts.

CLIFFORD *Feather-Weight* OIL COOLERS AND COOLANT RADIATORS

HYDRAULICALLY-FORMED BELLOWS

HYDRON Metal Bellows



deliver just the right impact

THE easily controlled, slow-hitting blows of CP Aero Riveting Hammers deliver just the right impact needed to insure tightly and uniformly driven rivets without crystalizing the rivet or stretching the surrounding metal.

CP Aero Riveting Hammers are produced in a wide variety of sizes, with a selection of handle styles and angle attachments to meet assembly conditions at hard-to-get-at places.

Aero Riveting Hammers are only a few of many pneumatic and electric tools in the world's largest line of aviation tools — riveters, drills, screw drivers, impact type wrenches and special-purpose tools.

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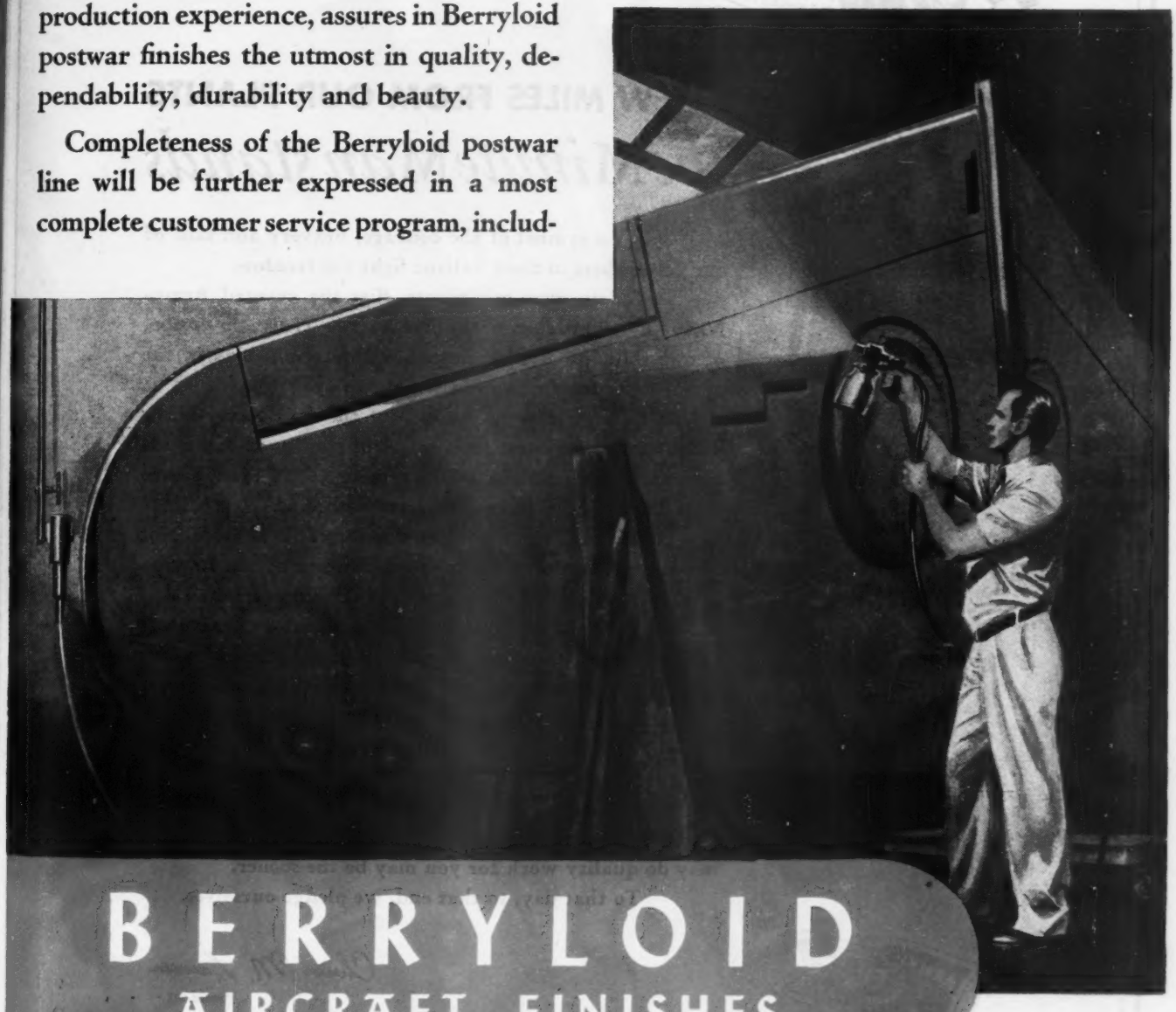
Your transition from wartime to peacetime production will be made easier by Berryloid finishing materials.

Over thirty years of leadership in the development and perfection of aircraft finishes, climaxed by unparalleled wartime production experience, assures in Berryloid postwar finishes the utmost in quality, dependability, durability and beauty.

Completeness of the Berryloid postwar line will be further expressed in a most complete customer service program, including distinctive color selections and efficient shop systems.

It will pay you to include Berryloid products and service in your peacetime production and sales planning.



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. . . a symbol of the courage, bravery and skill of our forefathers in their valiant fight for freedom.

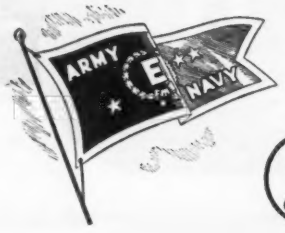
Today, over our plants, flies the coveted Army-Navy "E" award flag, with three stars — truly, the symbol of our skill, productive power and determination in the global fight for freedom in which we are engaged.

Of course we are proud of the four Army-Navy "E" awards, the latest recognition of continued outstanding production being issued November 16, 1944. We have been doing our job; thus, we have earned it.

We have more work to do, a great deal more. Not for one minute have the men and women of the Lawson Machine & Tool Company forgotten Pearl Harbor. Until the Day of Peace they are resolved to continue turning out the quality machining of precision parts that today are such vital requisites to total Victory. Until that day these same men and women will continue to buy War Bonds, to invest in America, in their future.

Now is the time for all Americans to buy that extra War Bond! Now is also the time for us at Lawson's to turn out those extra precision parts so that the day when we may do quality work for you may be the sooner.

To that day, to that end, we pledge ourselves.



Chester M. Lawson
President

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HANSEN manufactures not only the finest couplings on the market but the most diversified line of couplings ever offered to industry. Included in the Hansen line are couplings for air, oil and grease, another series for acetylene, one for gasoline, one for oxygen and another for steam.

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Hansen couplings are the simplest and quickest to operate, the easiest to connect and disconnect. Slight push of plug into socket, they are connected absolutely tight; easy pull on sleeve, they are disconnected. No twisting or turning to lock or unlock, no kinking of hose, no jamming or freezing of parts.

The last word in couplings is Hansen and this is proven by their tremendous popularity in industry all over the world. They are outstanding because of their simplicity, ease of operation, engineering soundness, economical operation and long life. There is no better coupling made anywhere at any price. Send for new free industrial catalog covering the complete Hansen line.

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TO NASC SPECIFICATIONS—Holo-Krome, from the first, produced NASC Bolts to the exacting standards of the National Aircraft Standards Committee.

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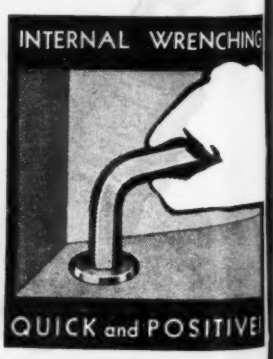

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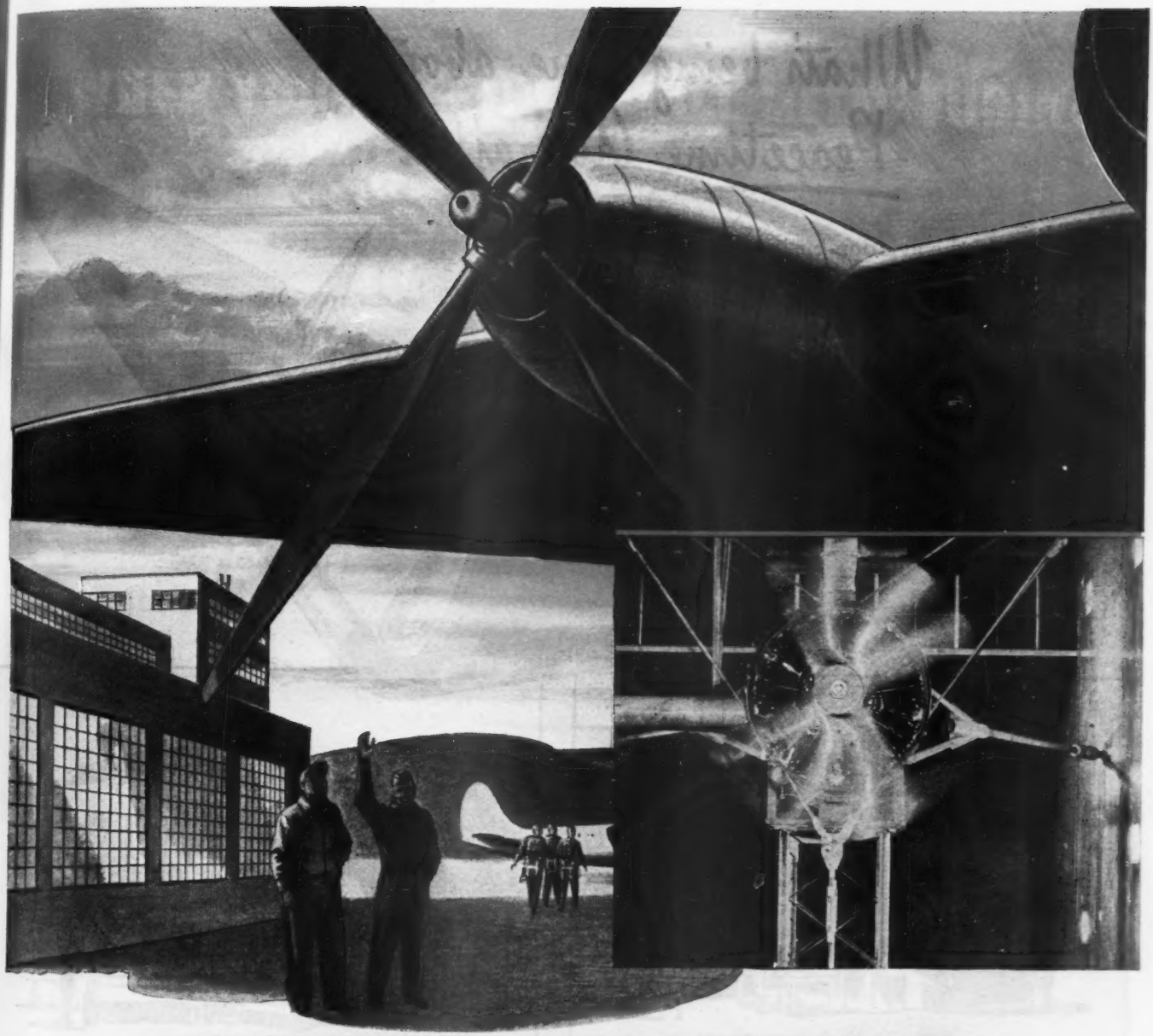

TEST CELL to NACELLE

THOUSANDS of Wright Cyclone airplane motors are rolling to completion down the production lines of America's giant aircraft engine plants. For their critical break-in runs, in the mammoth test cells of the Wright, Studebaker and Chrysler-Dodge plants, these Cyclones are lubricated with Wolf's Head Aviation Oil. From these test cells they are shipped to assembly plants to be installed in the engine nacelles of planes that are making America's Air Force supreme in the skies.

Since the early days of aviation Wolf's Head has engaged in constant research and development to keep pace with and anticipate the lubrication needs of the aircraft industry. When future aircraft engines are developed, Wolf's Head Aviation Oil will be ready to meet their needs in moving from test cell to nacelle—in war or in peace.

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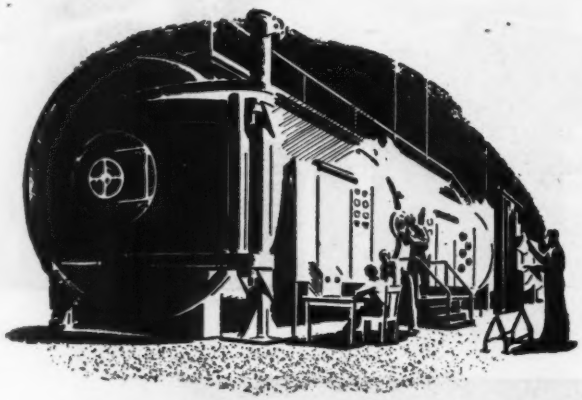
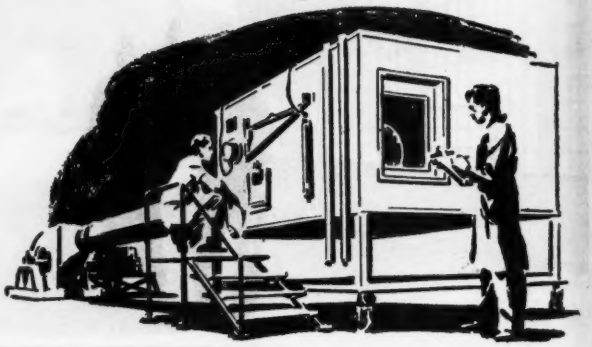
All of us in the aviation business are 100% in war production. That's as it should be. Meantime, we're also perfecting developments that will make for finer peacetime aircraft. Take these from our own experience:



We "have something" for high-altitude commercial flying. From research in our "Stratolab" has come tested, perfected equipment for pressurizing and heating cabins to make flying safe at altitudes undreamed of before the war. Here a new "high" in air travel has been born.



...and here tomorrow's ceilings are being made possible. AiResearch Wind Tunnel experiments have developed lighter-weight altitude-raising intercoolers ... aftercoolers ... non-congealing, all-aluminum oil coolers—ready *now* for adaptation to tomorrow's airliners.

After Research and Engineering ... Precision Manufacture. With complete facilities for precision manufacture, AiResearch will produce much of the specialized equipment needed to travel the rarified atmosphere lanes of the future. AiResearch Manufacturing Company, Los Angeles and Phoenix.

"Where Controlled Air Does the Job" Automatic Exit Flap Control Systems • Temperature Control Systems • Engine Air Intercooling Systems • Cabin Pressure Regulating Systems • Supercharger Aftercooling Systems • Engine Oil Cooling Systems

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TO OUR CUSTOMERS:

Final arrangements for the purchase by the Greenfield Tap and Die Corporation of The Geometric Tool Company of New Haven, Connecticut, have been completed.

The acquisition of this nationally known firm of precision tool-makers will broaden the base of Greenfield's service to industry -- in research, screw thread engineering, and in the production and distribution of a complete line of precision threading tools and gages.

The Geometric Tool Company, as you may know, makes self-opening die heads, chasers, collapsing and adjustable taps, chaser grinding fixtures and threading machines. Its experience fits in ideally with our own knowledge of cutting tools and gages.

We plan to operate The Geometric Tool Company as a division of the Greenfield Tap and Die Corporation, pooling our engineering and manufacturing experience to provide better threading tools and screw thread service than ever before.

Very truly yours,

GREENFIELD TAP AND DIE CORPORATION

D. G. Millar

President

D.G.Millar-M

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ARMY NAVY

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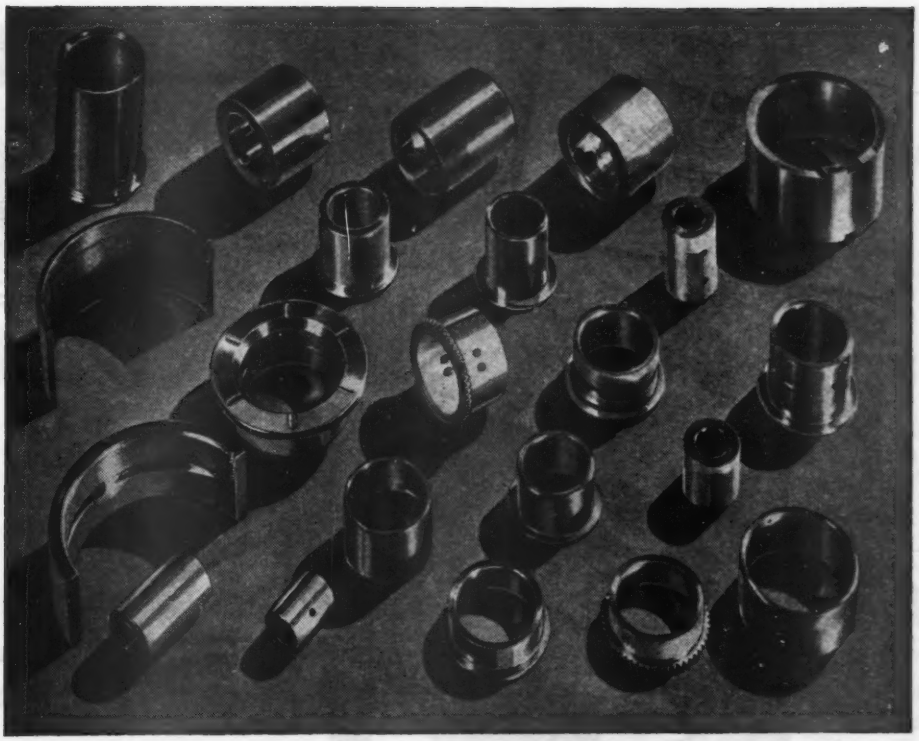
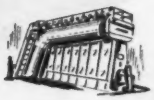
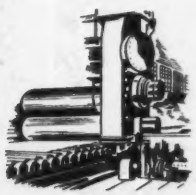
THE GEOMETRIC TOOL COMPANY
New Haven, Connecticut





Opening

A New Chapter in the History of Bearings



IN a few short years, silver has added a complete new chapter to the history of bearings.

Applied by the Mallory electroplating process . . . used in nearly every American fighting plane . . . silver has smoothed the way to seven-mile-a-minute speeds and thousands of revolutions per minute. Here it fights friction and heat . . . withstands crushing pressures and stresses . . . permits tolerances to 2/10,000 of an inch, and surface finishes measured in millionths of an inch.

But there are many other applications to which Mallory precision bearings are ideally suited—and other materials of which they are made. The list of products tabulated below is merely suggestive of their adaptability.

The point is that as Mallory precision bearings continue to be made, the Mallory program of research goes on and on. Improvements are being discovered continuously. New metals are being developed—some for heavy duty, others for light. Not least important, Mallory has established new and economical methods of producing precision bearings, in quantity, and final costs have been greatly reduced.

Nobody knows where the chapter will end. But wherever precision bearings must absorb unusual loads, stand up under high speeds, improve efficiency and performance—there Mallory experience will serve you well. Call on our engineers for assistance. They're ready to help you—*anytime.*

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MALLORY PRECISION BEARINGS

FOR AIR COMPRESSORS • AIRCRAFT, AUTOMOTIVE AND DIESEL ENGINES • ELECTRIC GENERATORS AND MOTORS • ELEVATORS • FANS AND BLOWERS • GOVERNORS • HOME APPLIANCES • MACHINE TOOLS • PUMPS • RAILROAD EQUIPMENT • ROLLING MILLS • STATIONARY AND PORTABLE ENGINES • STOKERS • TURBINES

Air—properly controlled—gives the glider its lift. Compressed air—controlled by Schrader Air Control Products—can give your industrial operations a lift.

Whether you're now working without compressed air, or haven't used it as much as possible, you'll find it can bring greater efficiency and safety to many types of machines and production methods. Applied thriftily and effectively by Schrader Air Control Products, compressed air adds new life and safety to war-worn machines, eliminates or reduces manual operations, relieves operator fatigue, and increases production while lowering costs.

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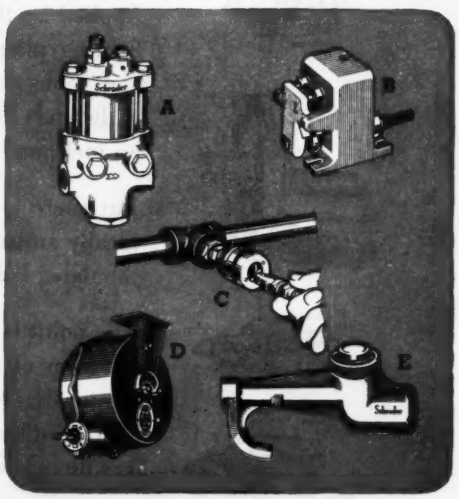
SCHRADER PRODUCTS are made in different sizes, packaged and stocked to meet your individual needs. See your industrial distributor or write today to Schrader, Dept. O, specifying the products in which you are interested.



A. Air-Timing Pilot Valves
B. Four-Way Operating Valves
C. Quick-Acting Air Line Couplers
D. Tuck-Away Hose Reels
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Air Valves 2, 3, 4-way • Air Operated Machine Controls
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Control the Air
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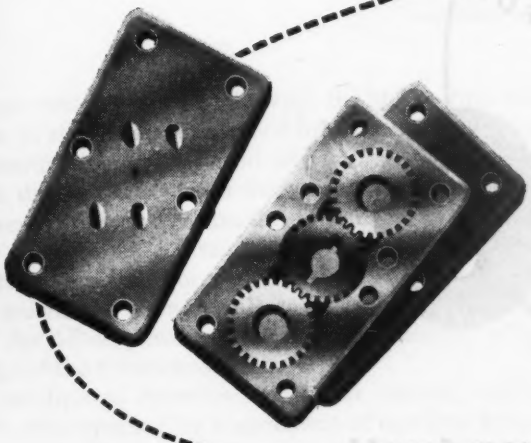
ANOTHER MASS-PRECISION ASSEMBLY BUILT BY NICHOLS

Putting the "No Ice" Sign



on an Airplane's Propeller

A propeller blade is certainly no place for an ice-pack. Neither is a pilot's windshield. Yet every drop of freezing rain that strikes these surfaces is potentially ice-forming... and dangerous.

W. H. Nichols & Sons has helped combat this natural "enemy" by producing a unique precision pump for an anti-icing unit which "beats ice to the draw" by spreading a thin film of alcohol on these exposed surfaces. The mixture of alcohol and rain with its lower freezing point quickly flies off as harmless vapor instead of turning to ice.

Metering such a thin fluid as alcohol with *exact, measured* distribution to both engines in a bi-motored plane presents many unusual manufacturing requirements. The pump must operate *completely without lubricant* to insulate the rubbing surfaces from one another. This means fine, flat surface finishes and strictest dimensional accuracy. Since the whole unit is powered by the plane's limited electrical supply, complete freedom from binding is essential.

Nichols mass-produced the close dimensions required... gears thicknessed to plus 0" minus .0001"... side plates flat to .0002" over 3½" length... bores in the centerplate held to plus .0002" minus 0". A high production rate was constantly maintained *without pre-selection of any parts* and the cost kept low.

Such performance is typical of Nichols' forty years of mass-precision manufacturing ability. Here unique facilities have been developed for producing the "hard" parts.

Perhaps you have an unusual precision problem—part or assembly—which can benefit from such a tradition of accuracy in mass-production. Talk it over with "Accurate" Nichols.

W. H. NICHOLS & SONS, WALTHAM 54, MASS.

"Accurate" *Nichols*

PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION

FOR TOP-FLIGHT PERFORMANCE

90%

of all

Aircraft carburetors

built

are made by **STROMBERG**

Those who are intimately acquainted with the aircraft industry know that year-after-year acceptance of a product does not come by chance or luck. The accepted product holds its place on merit alone.

Nor does success in one year guarantee success in the next. The vigilant eyes of the industry keep constant watch. The inferior product is dropped as quickly as its shortcomings are discovered. The good product yields its place to the better. In this ceaseless struggle for survival, only the best remains in use.

There is, then, in these inflexible statistics, a story of product excellence far beyond the power of mere words to describe:

For the past ten years, the aircraft industry has preferred Stromberg to all others by 8 to 1. 90% of all Aircraft Carburetors built are made by Stromberg.

Bendix PRODUCTS DIVISION

Bendix Aviation Corporation, South Bend 20, Indiana

WHAT DOES AMERICA WANT?

IT IS THE PURPOSE of this editorial, the thirty-first of a series, to state the urgent need for a clear declaration of American policy in world affairs.

Within the past few weeks there has been a wakening conviction in this country that the determination of international arrangements cannot safely be put aside until victory has been won. For we have seen actions taken in Europe seemingly without full consultation and agreement of the Allied powers, which may profoundly affect the design of the post-war world.

A declaration of American policy is needed, and it should be accompanied by a statement of our firm intention to exert full effort to procure its acceptance and furtherance. Emphatically, this does not mean that an American platform should be put forth as an ultimatum, which other nations must accept totally, or reject at the cost of having the United States withdraw from collaborative participation in world agreements and organization. On the contrary, the first plank in such an American platform should be a firm commitment on our part to participate with our associate nations in building a general system of world security and order. By definition, this requires that each participant be willing to accommodate its purely national interests to a program that can be accepted as fairly representing the interests of all. But equally, there is imposed on each participant an obligation to state honestly and openly what it conceives its individual interest to be, as well as its concept of what measures will best serve the general interest.

☆ ☆ ☆

Americans have displayed a singular diffidence in the matter of formulating a bill of American objectives—singular, in that it contrasts so sharply with our power to exercise as broad a leadership as we are able to define. This reluctance stems partly from the inherent difficulty of arriving at a coherent statement of national aims in a country like the United States—so vast in area, so multiple in its sectional and group interests, and so soundly committed to the free expression of individual thought. But it stems also, in part, from a tradition of national isolation which, however understandable in historic perspective, now stands clearly discredited by two world wars which were not of our making, but from which we were unable to hold aloof.

That the economic wellbeing and political security of the rest of the world is closely bound to the decision and performance of the United States is questioned nowhere but in America. Political boundaries and restrictions cannot build effective fences against the interplay of economic forces, and the sheer weight of American economic influence is of crucial import to all the other nations of this globe. In large measure their decisions will be shaped either in response to the opportunities that our procedures offer them, or in defense of interests that our procedures may jeopardize.

☆ ☆ ☆

The United States contains only about 6 percent of the world's population. But—our national income, before the war, amounted to almost 25 percent of world income; our industrial output as a whole approximates 45 percent of world totals, and we now are producing a like percentage of the world's munitions; we have 35 percent of the world's railroad mileage; 25 percent of merchant fleet tonnage; 50 percent of the world's telephones; 45 percent of steel production; 40 percent of aluminum production; 33 percent of coal output; we are refining (though part of the production comes from imports) 55 percent of the world's copper, and 70 percent of its petroleum; we now are producing 50 percent of the world's rubber (though post-war resumption of natural rubber production will sharply reduce this balance); our shares of agricultural production are, of course, much smaller, but just before the war we accounted for 35 percent of world cotton production, 15 percent of wheat, and 10 percent of wool.

Whether we like it or not, we must exercise political responsibilities commensurate with the weight of our economic power in an inter-dependent world. But before responsibilities can be assumed, they must be defined. Can the United States arrive at a clear agreement and statement of aims for which it is willing to stand sponsor?

The recent campaigns of both political parties have helped to provide an encouraging answer. In general, election mandates are glaringly deficient as indicators of a unified national purpose. A majority of voters declare themselves for the winning candidate. But even among the majority there are varying degrees of enthusiasm for the platform principles espoused by their candidate; and the substantial minorities of the defeated parties may have had no enthusiasm whatsoever for particular planks in the winning platform, or for the platform in its entirety. A sportsmanlike deference to the will of the majority is a feeble substitute for unified national conviction.

But this Presidential campaign was noteworthy for certain basic principles upon which both the platforms and the candidates of the major political parties were

united. Surely, upon such areas of agreement there may be said to have been an American mandate; the more so, because upon certain of them, we have evidence that no party or candidate could have declared opposition with any hope of victory. What then were these agreed-upon principles? The following is an attempt at a fair summary:

1. That America, in collaboration with its Allies, is committed to seeing the war through to the unconditional surrender of our declared enemies.

2. That America is committed to a responsible role in a world security system after the war, including a commitment to lend the support of our armed forces to repel aggressions that may violate such security.

3. That America is committed to the post-war goal of substantially maintaining in this country an economy that will provide jobs for those who are able and willing to work.

4. That America is committed to the principle of achieving this goal of sustained, high-level employment of manpower and economic resources under a system primarily activated by competitive enterprise.

These are American mandates. They can be made the nucleus of a coherent national policy, for they define aims upon which the great majority of our people are emphatically agreed. But no one can pretend that in this generalized form they serve as more than directional guides for either internal legislation or international negotiation. This skeleton of aims must be clothed with the living flesh of agreed-upon means. Here we have no national mandates of comparable clarity, but it is patently clear that it is our compelling task to achieve them.

☆ ☆ ☆

On our elected representatives in government rests the primary responsibility for formulating the specific programs required to implement national policies. Under our system of government, those representatives need continuous nourishment in the form of mandates as to what the people want. Particularly during a period when so many urgent problems are being thrashed out upon an international basis, this imposes a grave responsibility upon all sectors of our citizens; for it requires them to think in terms of the welfare of our nation as a whole, to focus upon those points which offer possibilities for substantial agreement among Americans, rather than upon matters of individual, group, or sectional advantage.

In earlier editorials I have tried to define a basis for national policy in keeping with that broad purpose. They have dealt with problems that are basic to the healthy functioning of free enterprise under the competitive system, with the mobilization of our resources for war and for reconversion to peace-time production, with labor and management responsibilities and relations, with national debt and taxation, with foreign trade and our economic relationships abroad, with the industrial development of backward areas. Since they have been presented in the McGraw-Hill publications, which reach a group broadly representative of all American industry, they have centered upon problems that have an economic rather than a strictly political import.

Future editorials, to appear during 1945, will deal with comparable subjects selected in recognition of the urgent importance for arriving at concerted definitions of national policy. I am fully aware that no individual or group can speak authoritatively for the American Nation. But I hope that an honest attempt to formulate sound concepts of national interest in crucial economic matters will help to crystallize American policy both by focusing agreement and by eliciting dissent.

☆ ☆ ☆

Here there is space only to indicate in broadest outline what I conceive to be desirable foundations for an economic policy for the United States:

1. The attainment of a high and sustained level of business activity and employment in the United States and in the world.

2. Active and expanding markets for world trade based upon fair competition rather than upon bloc agreements, discriminatory preferences, and cartel arrangements.

3. The encouragement of industrial development in nations that have been backward in that respect.

4. A recognition that hospitality to imports, rather than constituting a threat to national standards of living, offers in fact the most potent instrument for international bargaining that any nation can command.

5. A willingness to assume a responsible national role in international arrangements designed to provide such financial stability as may be needed to support mutually advantageous world exchange of goods and services.

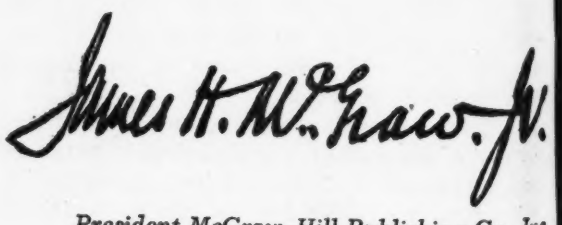
We must see to it that the end of military warfare does not merely open the door to an era of economic warfare.

The fact is that America has no choice but to assume leadership in world affairs. For the weight of our influence will be felt by other nations no less whether our attitude be positive or negative. And the cost to us of any international obligation which we might undertake must in all fairness be weighed against the equally real cost to us of dealing with measures that others may take to protect themselves against the results of our non-participation.

We have tended in the past to approach international commitments timidly, fearful that we might be outwitted in a world battle of wits. And in so doing, we have too often ceded to others the initiative of suggestion, leaving to ourselves the thankless task of accepting or rejecting what they demand of us.

Our one bargaining weakness stems from the fact that other nations, by contrast feeble in potential power, know what they want and are able to mobilize all their strength to achieve it.

America can be the most effective nation on earth—if only it knows what it wants.



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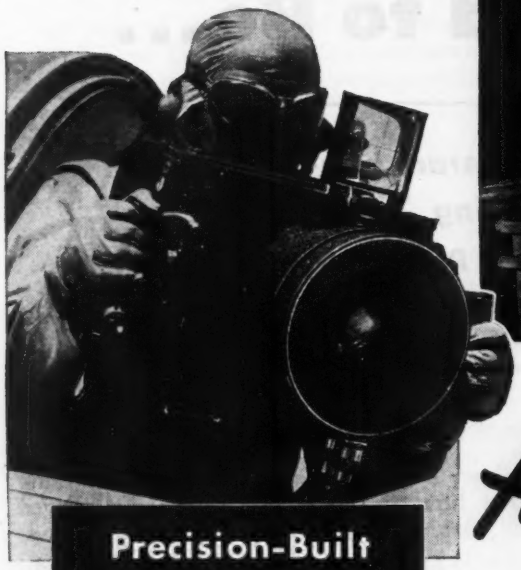
At Right: Small shutter parts being honed on Sunnen "MA" Precision Honing Machine.

Below: Navy photographer using Fairchild F56 Aerial Camera with 8¼" focal length for oblique photography.



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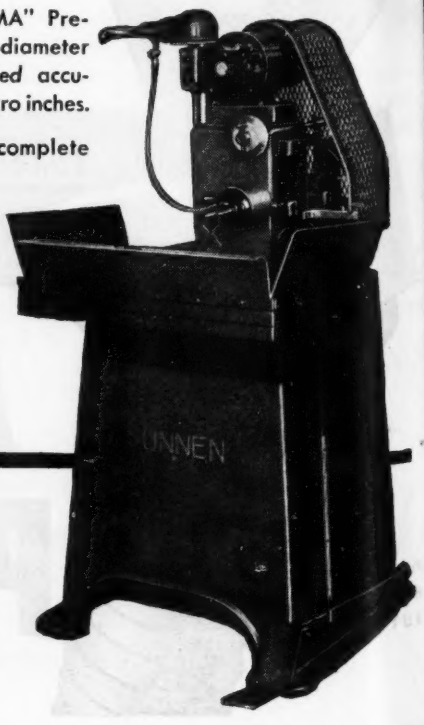

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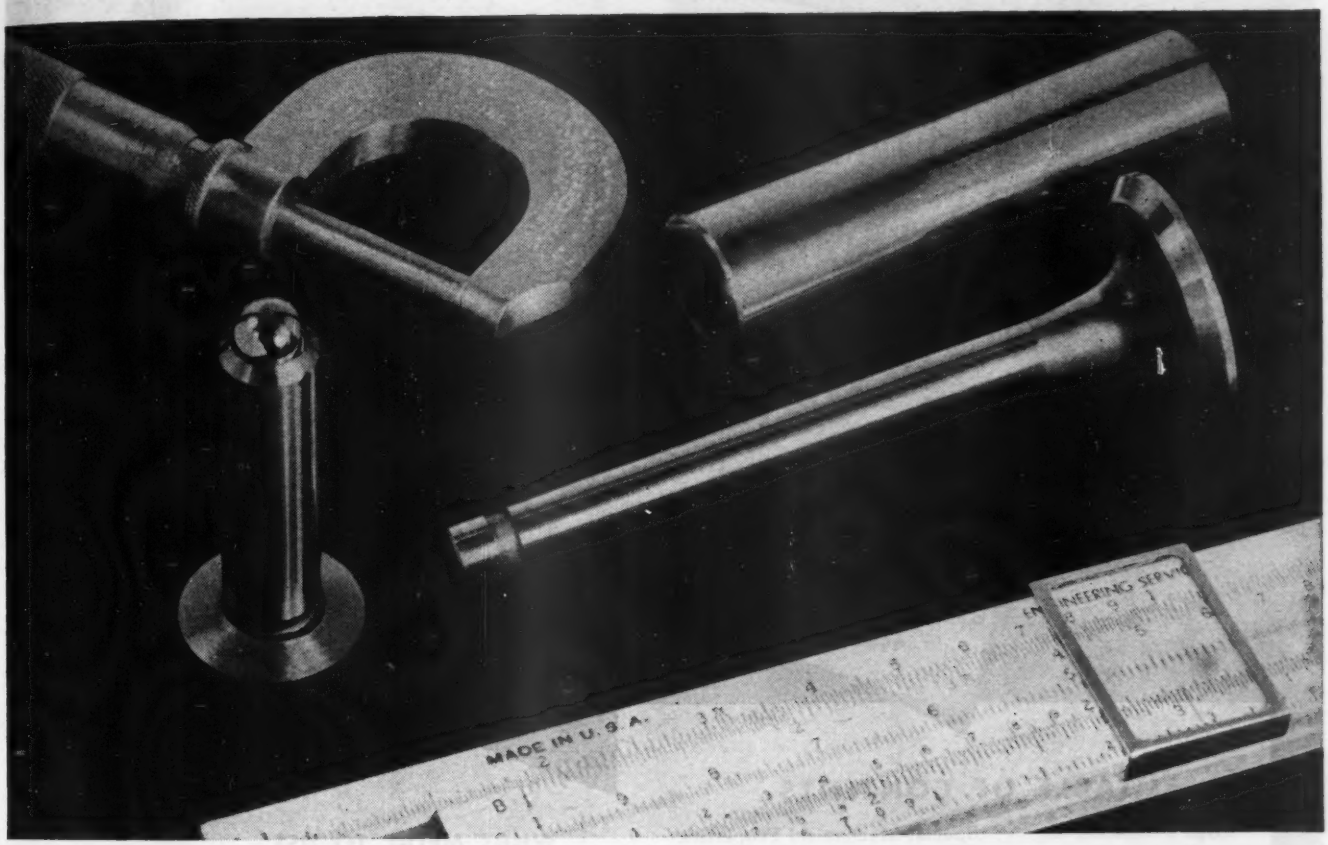

This unending care in manufacture and inspection results in a high quality aviation engine—that proves its "breeding" day after day in trouble-free operation, in economical and dependable service. Here is just one of the scores of enthusiastic reports on Lycomings. Mr. E. E. Marshall, adjutant of CAP Squadron 619-4, of North Cairo, Illinois writes . . .

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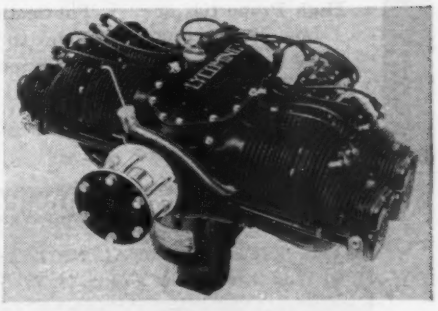

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Heat Transfer
Special Mechanical Properties
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Sustaining of Our Air Power Is USEFUL Work

OUT OF THE FIERY CRUCIBLE OF WAR, many changed ideas are emerging. One of the most important of these is the brand new thought that our physical and our economic security as a nation are supplementary and interdependent.

For many years we believed that the building of a defensive establishment constituted an overly great and undesirable strain upon our fiscal resources. The thought of spending public money on armaments was repulsive both for this reason and for the pervading reason that war was repulsive to a peace-loving people. It never seemed to occur to us that the building of armament constituted useful work and could furnish a livelihood for millions of our citizens. And so, when unemployment stalked throughout the land we turned to the age-old device of public works for relief. This idea dates back to the Pharoahs who built the pyramids chiefly to furnish employment for their people. Some of our public works projects could be compared with the pyramids in uselessness.

If we had had the vision to solve our employment problem in the last depression by building up our air power, together with our land and sea power, it might have been possible to avoid this terrible war. It is certainly not mere coincidence that the Japs attacked us at precisely the moment when our up-reaching curve of aircraft production crossed that of the Axis. Our enemies knew full well that their advantage over us was ebbing rapidly and they had to strike then or never.

OUR FUTURE PEACE depends directly upon our success in never letting our air power lapse again. The new developments in the fast moving technology of aviation, radio, and related fields are far too dangerous for us to risk another let-down in the strength of our air power.

It is only within the past few months that we have clarified our conception of air power. We now know that it embraces far more than our powerful striking forces. It includes not only air forces but both scheduled and non-scheduled air transport and aircraft production. All three of these elements must be maintained at the proper quantitative and qualitative levels. And the quality of all three can be maintained only by continuous and effective research, design, and development in all branches of aviation.

ALONG WITH THIS NEW CONCEPT has come a sound and dispassionate appraisal of our air power in terms of the results it has achieved so far in this war. This important work is soon to appear in book form under the authorship of Eugene E. Wilson, whose brilliant background in naval service and manufacturing qualifies him particularly well to make an impartial estimate. The forthcoming book is purely factual, leaving the reader full freedom to draw his own conclusions on the future course of our air power policies. On page 112 will be found the first of a series of articles based upon selected excerpts from the manuscript.

One of the brightest spots in the picture is the new-found knowledge that we need not deny ourselves the luxuries of life to maintain the supremacy of our air power. Under a system of private enterprise the proper maintenance of air power will contribute greatly to the postwar employment of our people; a condition which must be fulfilled to keep our national economy sound. And thus we have found a new formula to maintain our physical and economic strength as a nation and to utilize our technological talents to maintain peace and prosperity.

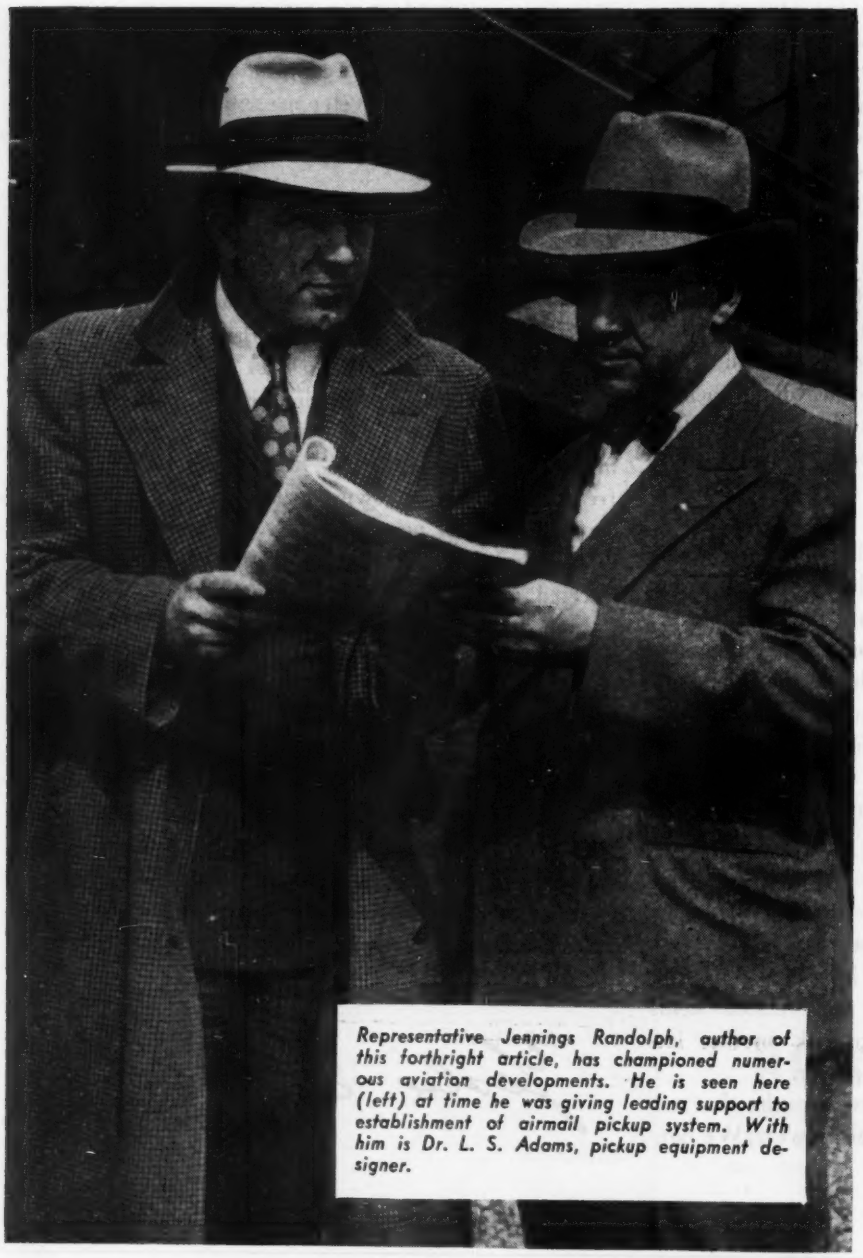
Leslie E. Neville

EDITOR

BUILDING MAIN STREETS FOR AMERICA'S AVIATION

By **JENNINGS RANDOLPH,** *Member of United States House of Representatives*

An airminded Congressman who has sponsored development legislation points out the urgent need for airport expansion and sets forth guiding policies for the program.



Representative Jennings Randolph, author of this forthright article, has championed numerous aviation developments. He is seen here (left) at time he was giving leading support to establishment of airmail pickup system. With him is Dr. L. S. Adams, pickup equipment designer.

MEMBERS of the new 79th Congress, beginning their work this month, face a challenge of providing the necessary legislation for a nationwide airport construction program. They are alert to the problem and to the general support for such an undertaking.

One of the final legislative acts of the 78th Congress was passage of the postwar highway bill authorizing approximately $1,700,000,000 of federal funds—to be matched by state funds—in building over a three year period a system of new and improved roads throughout America. Highways and skyways (plus a great rail and water system) make this country the leading transportation nation of the world. We must keep it thus.

The Secretary of Commerce, acting through the Civil Aeronautics Administration, only a few weeks ago sent to the House of Representatives a national airport plan. This survey report resulted from the intense desire of the Congress for definite blueprints from which necessary legislation might be formulated at an early date.

The report recommended building of 3,050 new airports and improvement of 1,625 existing fields. Estimated cost is $1,021,567,945 for clearing, grading, paving, lighting, and radio facilities, plus about $230,000,000 for land and structures other than hangars.

A system of federal aid, with state matching of funds, was proposed for financing the construction over a period of five to ten years. An immediate appropriation of $3,000,000 to cover the cost of surveys and other preparatory work was asked. The study checks the communities where airports should be constructed, and the number and classes of such airports, but it does not indicate specific sites.

Called for in the program is construction or improvements to increase the number of Class 1 airports—those essentially for personal flying—from 981 to 2,597; Class 2 fields—suitable for feeder airlines as well as personal flying—from 810 to 2,198, Class 3—which accommodates present-day twin-engine aircraft—from 443 to 654; Class 4—serving larger aircraft now in use—403 to 520; and Class 5—for long-

range domestic or foreign operations —305 to 336.

Moreover, the report shows that while the $400,000,000 national defense landing-area program conducted by the CAA since 1940 has been the chief factor in increasing the number of Class 3 or better airports from 57 to 1,094, deficiencies continue to exist at 174 locations now designated for air carrier service, and also at 585 points to which airlines propose new service.

In preparing the survey, population, trade, mail, airline traffic, route applications, and many other economic and geographic factors, were considered. The proposal set forth the number of new airports for metropolitan areas, but at the same time set up facilities for sections whose vast spaces make the airplane a logical form of transportation.

The CAA is now conferring with representatives of state and local government organizations in an attempt to reconcile differences as to how federal airport construction money should be allocated and distributed to the states, if and when Congress provides the $1,000,000,000 proposed in the bill, HR 5024, which I have sponsored, or some similar measure. Conferees include the Council of State Governments, the National Assn. of State Aviation Officials, the American Municipal Assn., and the U. S. Conference of Mayors.

Important points in controversy are the apportionment formula (as shown in the accompanying table) and the present provision of the legislation that federal airport money be channeled through state aviation agencies. Larger cities, speaking through the U. S. Conference of Mayors, believe that they will get better treatment if the apportionments are made direct to municipalities rather than through state agencies.

Study of the proposed amendments are under way, and it is believed something of conciliatory nature may be offered when the legislation receives consideration before members of the House Interstate & Foreign Commerce Committee, which is headed by the able chairman, the Hon. Clarence Lea of California, and the equally able chairman of the subcommittee on aviation, the Hon. Alfred L. Bulwinkel of North Carolina. It is my feeling that these hearings will be among the most important ever held in Congress on a subject dealing with transportation.

The CAA, in advocating more airports, stated in the Congressional report that "The airport is the basic facility of aviation just as the highway is the basic facility of automotive transportation, or harbor facilities are basic to water transportation. By investing $25,000,000,000 in roads during the last 25 yr., we have made it possible for the United States to become a nation on wheels—with 32,000,000 motor vehicles in operation during normal times. For a much smaller investment, we can start the United States on its way toward becoming a nation on wings, with all that implies in war and peace."

Charles S. Rhyne, counsel for the National Institute of Municipal Law Officers, with whom the author has frequently disagreed on the distribution of federal airport funds, tells the interesting story of the "unbeliever" who, in 1928, opposed the issuance of $2,000,000 in city bonds by St. Louis for an airport development. This short-sighted individual attacked the bond issue as a "private" rather than a "public" purpose. His declaration regarding the airport developments follows:

It will afford a starting and landing place for a few wealthy, ultra-reckless persons, who own planes and who are engaged in private pleasure flying. They may pay somewhat for the privilege. It will afford a starting and landing place for pleasure tourists from other cities, alighting in St. Louis while flitting here and yon. It will offer a passenger station for the very few persons who are able to afford, and who desire to experience, the thrill of a novel and expensive mode of luxurious transportation. The number of persons using the airport will be about equal to the total number of persons who engage in big-game hunting, trips to the African wilderness, and voyages of North Pole exploration. . . .

In the very nature of things, the vast majority of the inhabitants of city—a 99 percent majority—cannot now, and never can, reap any benefit from the existence of an airport. True, it may be permitted to the ordinary common garden variety of citizen to enter the airport free of charge, so that he may press his face against some restricting barrier, and sunburn his throat gazing at his more fortunate compatriots as they sportingly navigate the empyrean blue. But beyond that, beyond the right to hungrily look on, the ordinary citizen gets no benefit from the taxes he is forced to pay.

The Missouri Supreme Court, with foresight, replied to the narrow-minded plaintiff with this belief:

An airport with its beacons, landing fields, runways, and hangars is analogous to a harbor with its lights, wharves, and docks; the one is the landing place and haven of ships that navigate the water, the other of those that navigate the air. With respect to the public use which each

(*Turn to page* 241)

State	Apportionment	State	Apportionment
Alabama	$1,263,651.16	Nevada	$2,568,765.65
Arizona	1,914,417.22	New Hampshire	267,977.67
Arkansas	1,687,828.41	New Jersey	2,031,273.44
California	2,642,394.52	New Mexico	1,852,615.10
Colorado	2,316,754.36	New York	7,902,621.45
Connecticut	799,879.51	North Carolina	2,008,570.39
Delaware	52,423.30	North Dakota	1,223,253.08
Florida	985,339.45	Ohio	4,104,326.35
Georgia	1,826,398.43	Oklahoma	1,491,193.90
Idaho	1,199,748.47	Oregon	2,000,704.39
Illinois	5,576,380.72	Pennsylvania	6,256,597.44
Indiana	2,630,438.10	Rhode Island	478,230.24
Iowa	2,389,392.20	South Carolina	1,106,982.85
Kansas	2,091,249.51	South Dakota	1,933,425.95
Kentucky	1,946,779.90	Tennessee	2,318,154.15
Louisiana	1,142,629.05	Texas	5,024,633.77
Maine	590,249.23	Utah	1,997,673.85
Maryland	1,075,275.70	Vermont	257,020.18
Massachusetts	2,041,905.36	Virginia	1,240,910.11
Michigan	2,880,135.45	Washington	1,564,230.88
Minnesota	2,687,430.69	West Virginia	1,227,002.75
Mississippi	857,021.70	Wisconsin	2,013,195.69
Missouri	2,926,455.96	Wyoming	2,060,259.58
Montana	2,111,191.29		
Nebraska	1,435,011.45	U. S. Total	$100,000,000.00

Formula: $$m = \left[\frac{\frac{a^2}{d}}{\Sigma\frac{a^2}{d}} + \frac{\frac{b^2}{d}}{\Sigma\frac{b^2}{d}} + \frac{\frac{c^2}{d}}{\Sigma\frac{c^2}{d}}\right]\frac{M}{3}$$

m = State share of funds.
M = $100,000,000.00 federal funds available for apportionment.
a = Population of state according to 1940 census. District of Columbia's population of 663,091 was deducted from U.S. total and was not included elsewhere.
b = Area of state according to Rand-McNally Atlas; District of Columbia's area of 69 sq. mi. was deducted from U.S. total and was not included elsewhere.
c = Number of registered civil aircraft by states with valid airworthiness certificates as of Jan. 1, 1944. Owner's mailing address was used. Air carrier aircraft in scheduled operation were deducted from total for state in which they were registered and from U.S. total. Also deducted from U.S. total were all aircraft registered in District of Columbia.
d = Number of civil airports as of Apr. 1, 1944. Included are CAA. intermediate fields and civil fields taken over by Army and Navy. Not included are Army- and Navy-owned fields and airports in District of Columbia. Because no tabular information is available, seaplane bases are not included.

Apportionment table and formula proposed for dividing $100,000,000 of federal funds in airport building program.

Air Power—The Key To Peace and Prosperity*

PART I

By **EUGENE E. WILSON,** *Vice Chairman, United Aircraft Corp., and President, Aeronautical Chamber of Commerce*

An outstanding industry leader analyzes the airplane's role in shaping the course of world history—as a basis for establishing American air policy.

AIR POWER is the most dynamic of modern international influences. It is rapidly taking on a new, broad meaning that goes far beyond the concepts of its prophets, Douhet, Mitchell, and others.

Curiously enough, while the influence of war on land has long been understood, it was not until 1889, when Capt. A. T. Mahan, USN, published his classic work *The Influence of Sea Power on History,* that men began to appreciate the bearing of maritime power upon events. According to Mahan the general historians, unfamiliar as they were with the sea, had overlooked the profoundly determining influence of maritime strength upon great issues. On the other hand, naval historians neglected the relationship between their own subject and general history.

Mahan successfully bridged the gap, demonstrating conclusively that since the dawn of maritime power, communication by sea had exercised a decisive influence in war and peace.

A complete and precise analysis which will disclose the influence of Air Power on history must await full information and the painstaking efforts of another Mahan. Meanwhile, an analysis calculated to disclose fundamental principles will afford a basis for understanding current events and making decisions that are even now upon us. By reviewing the record of the past, we can make discoveries that will help shape the future.

Since the airplane is but 41 yr. old, its whole history is compressed into the lives of a generation of men who participated in both World Wars. Our very nearness to the record may make it difficult to view the picture objectively. But at the same time, it should be possible for some of us who have lived it intimately and who understand the spirit which created it, to appraise its real character.

First, however, it is well to define our terms, for Air Power is the sum total of three things: *Air Force,* which is the actual striking force; *Air Commerce,* the system for moving men and materials throughout the world; and *Aircraft Production,* the foundation on which both Air Force and Commerce rest.

Recent history shows that Germany, Japan, and Italy, seeking to dominate the world through conquest, endeavored to exploit a revolutionary instrument to their advantage. Germany, a continental power hemmed in on all sides on land and by the British at sea, resorted to total war, combining propaganda, economics, and force in a titanic effort to attain world domination. She exploited fear of her air force to great advantage in the early phases to win almost bloodless victories. She then utilized the blitzkrieg to bring others under subjugation.

Air power was decisive weapon in African campaign, author Wilson points out. He also notes that Germany, after Allied sea power had closed the Mediterranean, supplied Rommel by air transport up to the time Allied Air Power denied her this means. U. S.-built Martin Marylands, such as those above, supported ground forces and proved a key factor in winning that campaign. (British Combine photos)

Only Britain resisted strongly enough to deny her complete victory through air force. Germany not only used the airplane as long range artillery, but contributed the further idea of air transport and airborne infantry.

But even without defeating England she made tremendous advances. By bringing the whole of Europe into her "New Order" she made her area of influence almost self-sustaining through either natural or synthetic materials. Swedish iron ore, Rumanian oil, Russian manganese—these are but a few of the strategic materials she had available. The lesson of the influence of sea power and the might of the British blockade in the first world conflict had been well learned. In the second, Germany lacked nothing.

And she made doubly sure of these materials by seizing a coast line so extensive that no effective blockade could be maintained against her. On the contrary, she turned the tables against Britain and blockaded her by air, by submarine, and by surface ship. Further, she cut the life line to India and, save for the allied stand at El Alamein, might have linked up with a victorious Japan to rule the world.

In the African campaign, when a battered remnant of the British Fleet denied her sea communications across the Sicilian Straits, Germany resorted to air transport and supported Rommel with it right up to the end, when Allied air forces denied her all communication to Africa.

Through failing to exploit the full use of air force, Germany failed in one of the boldest bids of history, even though she came within wingspan of success. And Air Force was the decisive instrument through which she hoped to succeed. The instrument remains for others to use.

After El Alamein, this new sword was turned *against* Germany. Allied Air and Sea Power turned back the submarine threat. Allied Sea Power transported the products of the Allied arsenals to the points of assault. While Russia moved westward, Italy was taken and the invasion forces were poised on England, the unsinkable aircraft carrier. And England, long saved from over-water invasion from the Continent by that narrow ditch, the English channel, now turned to assault

* From the manuscript of the author's forthcoming book *Air Power and Peace.* (McGraw-Hill Book Co.)

of the Continent over the same water.

The magnitude of this concept is lost to us against a background of titanic happenings, but history will record its boldness, and it simply could not have been undertaken save by exploiting the third dimension. The British Air Force night bombers joined hands with the U. S. Air Force day bombers to soften up the mightiest power in history.

On the face of this, if Germany—under all the advantages she had in 1940—could not reduce England, what chance had the United Nations to subdue Germany? Here again we see the broad scope of the whole idea. It will be interesting to know, some day, what leaders conceived such an idea.

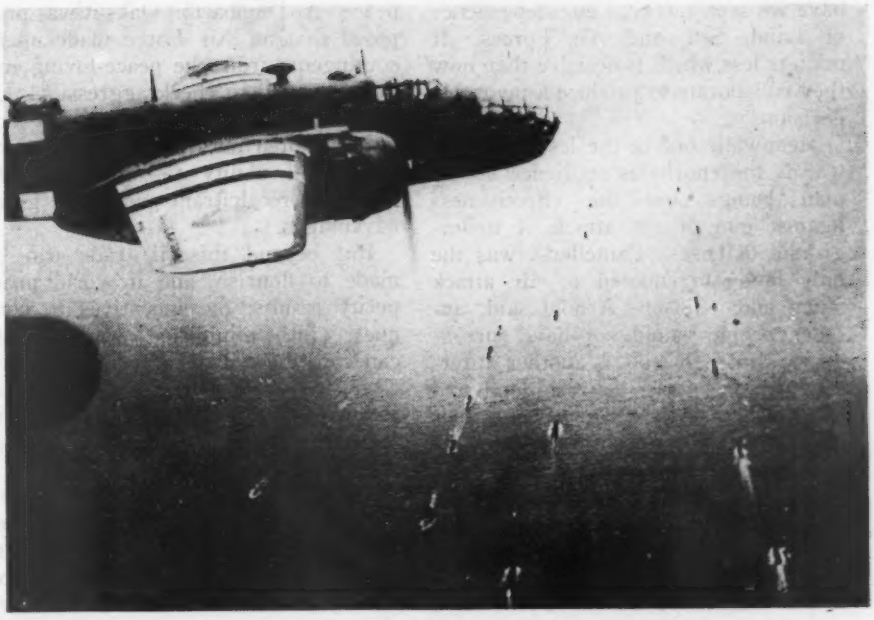
As we have seen, Allied air forces steadily increased their efforts in the face of heavy losses. In a single week in Feb., 1944, they brought the assault to a furious climax and knocked the Luftwaffe groggy. Bomber attacks on selective objectives, launched from England and Italy, forced the Luftwaffe to come out and fight. In a tremendous mass assault, individual combats gave free play to individual courage and proficiency. The Allied air forces defeated the Luftwaffe on its home grounds as much through sheer courage as anything else.

With the Luftwaffe reduced from a first rate Air Force, invasion preparations went on. When the signal was given, the attack was made under perfect air cover, and light unarmored vessels operated with impunity right up to the invasion coast. Thanks to the denial of air reconnaissance to the enemy, surprise was attained. The airborne division seized its objectives and joined up with ground forces. But most important of all, Air Force denied freedom of movement to the enemy reserves so completely that they could not be brought to bear.

Here is the perfect pattern of Air Force completely integrated between reconnaissance, long term and near term striking forces, troop support, and airborne ground forces. With it, success crowned the Allied effort in the face of almost insuperable difficulty. There can be no question as to the decisive character of Air Force. It made possible the German onslaught in the beginning and turned it back on the Nazi homeland in the end.

Meanwhile we must not lose sight of the fact that none of this could have been possible without Allied command of the sea and of the air over it. In Europe we have fought a continental war with an overseas expedition. In the Pacific we have so far fought a war for command of the sea.

We have seen the Japanese, like the Germans, bent on conquest of territory



During Allied invasion of France, "the attack was made under perfect air cover, and light unarmored vessels operated with impunity right up to the invasion coast. Thanks to the denial of air reconnaissance to the enemy, surprise was attained."

to gain the resources which they argue are essential to support the level of employment and standard of living they consider necessary to their people and to gain the economic power required to build and sustain military force with which to dominate their selected sphere. They, too, sought to exploit a new force—air—to this end. To secure the long line of communications to the Indies, they immobilized the U. S. fleet at Pearl Harbor, seized the Philippines, and established an island network of bases for shore-based aircraft.

The United States, recovering quickly from the staggering blow, stemmed the onrushing tide at Guadalcanal, Coral Sea, Midway, and Kiska, and then thrust a three-pronged trident into far eastern waters. The northern prong followed the direct air route blazed by the Lindberghs—North to the Orient. The southern prong followed the coast of New Guinea, and the middle prong, the Central Pacific island route to the Marianas.

Reviewing the important actions, we note the decisive character of Naval Air Force. Battles were fought at long range with aircraft alone—air battles directed against the enemy air forces, principally carriers. And once command of the air was lost the enemy fled. Battles were fought at short range, too, and whenever such range came within, say, 25 mi., the gun and torpedo carriers had their day.

This goes to show that all weapons are weapons of opportunity. It is idle to speak of obsoleting one with the other. Changing tactical conditions change the requirements for weapons. A commander must be ready to use the right one at the right time and place. At Leyte guns came into play, but aircraft were again decisive.

And in fleet actions, many of them beyond the range of shore-based aircraft, aircraft were brought to bear "on the backs of the fleet" itself. The Pacific campaign could hardly have been fought without Naval Air Force. The task of dislodging the Japanese from all the places they had occupied would have been almost impossible. And all of them must have been occupied had not Air Force neutralized most of them. And the task of retaking the Philippines or of invading China or Japan against the great Japanese army would have been well nigh impossible.

If the European continent could not have been invaded from England without air superiority, Japan could not have been invaded from San Francisco. And Japan could not have been blockaded successfully with Korea and Manchukuo behind her.

So here, again, we observe that Air Force offered Japan the chance of a lifetime to attain her enduring ambition. We see that here, too, Air Force was turned against her to deny it. Air Force is decisive at sea as on land through its power to control communications by sea.

But neither by land or sea did Air Force alone win victory. This idea, inspired by the intense zeal of early aviation enthusiasts, has been completely disproved by experience. Even had the Air Forces brought Germany to her knees before the invasion they still could not have done it alone. The blockade by sea, and many other factors, must have contributed. Rather

have we seen the vital interdependence of Land, Sea, and Air Forces. It matters less which is decisive than how they collaborate to produce a favorable decision.

Meanwhile one of the lessons of the war is the enormous resilience of human beings and the effectiveness against gun or air attack of underground defenses. Pantelleria was the only land surrendered to air attack alone and, as Gen. Arnold said, another people would not have surrendered. But here, too, is another difference among many between land and sea warfare. At sea it is not a matter of resilience of human beings but of buoyancy of the vessel. And the torpedo, striking as it does under the belt, and under conditions most favorable to it, is a knockout weapon indeed.

What we have witnessed in this war is the emergence of Air Force as a complete entity. It does not obsolete weapons, nor is it an "arm" of any other force. It is a force in itself.

It has brought forth two distinct entities—Naval Air Force and Army Air Force. Naval Air Force, operating on the high seas, enjoys the added mobility of sea-borne bases. The Army Air Force, operating over land and sea is limited to fixed bases. Within the radius of its self-contained operations Army Air Force is the dominant force. Outside this radius it is dependent on Sea Power. And Sea Power in turn is dependent on Naval Air Force. Fundamentally, therefore, Air Force has clearly demonstrated its decisive character.

This decisiveness bids fair to increase rather than to decrease, because the technology of the air is but upon the threshold of new developments. Technological improvement tending to increase speed will profoundly affect future tactics. Increased range is vital to Army Air Force functions.

Now, even though Germany and Japan are being defeated, the possibility of world conquest still remains. Air Power alone can keep in check any effort to exploit this opportunity. The dominant Air Power must be kept in the hands of free people. England and the United States did not use their dominant Sea Power for conquest, but rather sought to bring freedom to others. Germany and Japan saw Air Force as the means of conquest. It was not unnatural that free peoples discounted the preparations of the aggressor nations because war for conquest was not in the realm of their understanding.

I have used the expression Air Power deliberately above. For just as Air Force alone did not win the war, so Air Force alone cannot keep the peace. At Dumbarton Oaks it was proposed that an Air Force made up of contingents from the peace-loving nations be used to check aggression. Of course, of all the forces, Air Force is best suited for this because its mobility and ability to strike directly against a recalcitrant people are great advantages.

But beyond this, if trade can be made to flourish, and if world prosperity results, the incentives to conquest will be minimized. Air transport can contribute materially to this. Just as the railways sparked reconstruction following World War I, so can overseas air transport influence world recovery through improved facilities for world trade.

On the domestic front of countries like the United States, where air transport offers advantages, its expansion can likewise contribute to recovery through new employment, new investment opportunities, readjustment, and an accelerated tempo of expanded domestic trade. A healthy aircraft manufacturing industry can contribute its share through technological developments calculated to enhance the usefulness of air transport while providing for national security.

Air Power in all its three elements—Air Force, Air Commerce, and Aircraft Production—can become a constructive force for world peace. And the United States, of all nations, must keep in the forefront of air development. This fact is clear to anyone who examines a world globe.

"The Pacific campaign could hardly have been fought without Naval Air Force," where "battles were fought at long range with aircraft alone—air battles directed against the enemy air forces, principally carriers. And once command of the air was lost, the enemy fled."

In an interesting book, *The Geography of World Air Transport*, J. Parker Van Zandt points out that "Most of us have a mental picture of a world that isn't so. This is due to the common use of the flat maps to show the entire world. The map that lies flat, lies."

If we spin the globe till we are looking at the earth's center through a point near Nantes, in France, we will be looking at a hemisphere whose surface comprises nearly 94 percent of the people of the earth, 98 percent of its industry, and the major portion of its natural resources, technical skill, and financial strength. By geographical accident, Europe holds the prime position with the advent of Air Transport.

This places the United States on the periphery of the world's major trading area. The somewhat great average distances to be flown will place a premium on Air Transport, because the greater the distance flown, the greater the dividend paid by speed. But to offset the handicap of cost, more efficient operations, reduced cost through increased volume, and better technology will be required. This places an additional premium upon technological development.

Van Zandt divides the principal hemispheres into seven regions, and he points out that four of them—Greater Europe, North America, Soviet Russia, and Asia—dominate the world. Over nine-tenths of the world's income is earned in these four regions.

Four principal factors influence the world airway pattern:

1. Potential traffic between terminals along the route;
2. Availability of airway aids and facilities;
3. Length of the greatest unavoidable non-stop flight; and
4. Flying weather.

These considerations dictate three gateways to the United States. Alaska is the logical gateway from Asia for traffic originating as far south as Darwin, and as far inland as the Burma-India border; Labrador is the aerial gateway to Greater Europe, Africa, and Western Asia; not only all cities along the southern border, but communities hundreds of miles inland are potential ports of entry to Latin America.

Van Zandt further demonstrates that no nation has a corner on international air routes. The most strategic territories lying athwart the network of world airways can be bypassed if necessary. The economic range of modern transport aircraft has eliminated the last irreplaceable airport. This striking contrast to the maritime situation —wherein Gibralter, Suez, Panama, and Singapore (to name but a few) are control points—is indicative of the impracticability of controlling the air in the sense that the sea is controlled.

(*Turn to page* 246)

Industrial Research Is a Postwar Indispensable

PART I OF A SERIES

By K. R. JACKMAN, *Chief Test Engineer, Consolidated Vultee Aircraft Corp., San Diego*

Finding a crying need for better documentation of our many steps forward, the author further sees a lack of sharp attention to what "the other fellow" is doing. Moreover, he warns that research will suffer irreparable damage unless the trend toward paralyzing postwar economies is curbed . . . . First of an important new group of articles gaging the meanings and values of research.

"One must learn by doing the thing; for though you think you know it you have no certainty, until you try"—Sophocles, 445 B.C.

"Wise men will gather around the table and prove conclusively that a thing cannot be done; at the same time an untaught genius, too ignorant to know the thing cannot be done, will go ahead and do it"—Steinmetz, 1925 A.D.

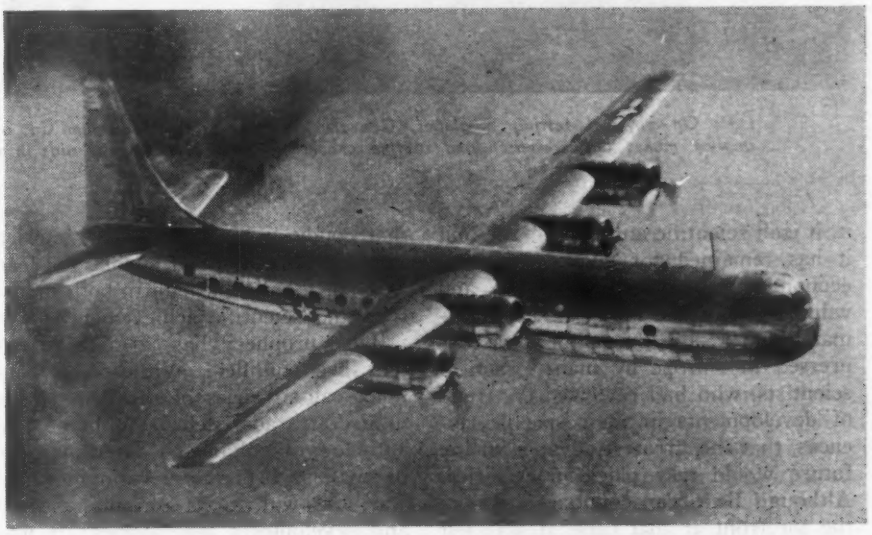
IS ROMANCE DEAD? Have the frontiers for exploration been closed to America's youth? Not to the young man or woman with sufficient training to enter the portals of research and its substantiating test laboratories.

True, there may be no more "seas of darkness" for a contemporary Columbus to conquer, few untracked jungles, not many unscaled mountains; but in scientific research ("the pathfinder of science and industry," as T. A. Boyd[1-1], has so ably expressed it) the technically trained modern adventurers may still find thousands of untried doors and many uncharted vistas.

Surely Adm. Perry could not have visualized the unlimited exploration possibilities in today's and tomorrow's scientific world when, after his conquest of the North Polar regions, he said "The last great earth story has been told". He was partially correct in that there are few virgin geographical areas for the modern explorer to invade but the research engineer's fields of the microscopic, supersonic, infrared, ultraviolet, and hundreds of similar new horizons, offer more regions unexplored than to date have been explored.

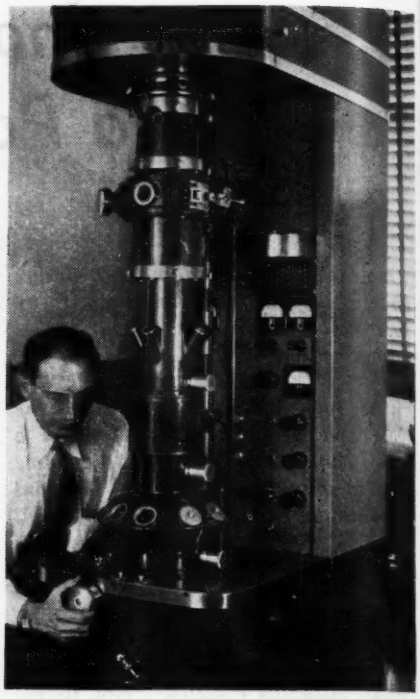
Science, according to R. A. Millikan, is after all merely the growth of man's understanding of his world, and hence of his ability to live wisely in it. "Research", to most people, implies association with the fields of conventional science and not with industrial applications. That was more true yesterday than today. Even today many laymen believe that scientific or research matters mean those that are obscure. Dr. Kettering has said that "a scientific thing is just anything you don't understand. As soon as you do understand

[1-1] (All references are collated at the end of this article, page 262).)



Research shapes the travel of tomorrow. Shown is Convair's clean-lined Model 39 Liberator-Liner. (Otto Menge photo)

Helmet-caparisoned test engineers try new aircraft control system in sub-zero chamber of low-temperature laboratory. (Douglas Aircraft Corp. photo)

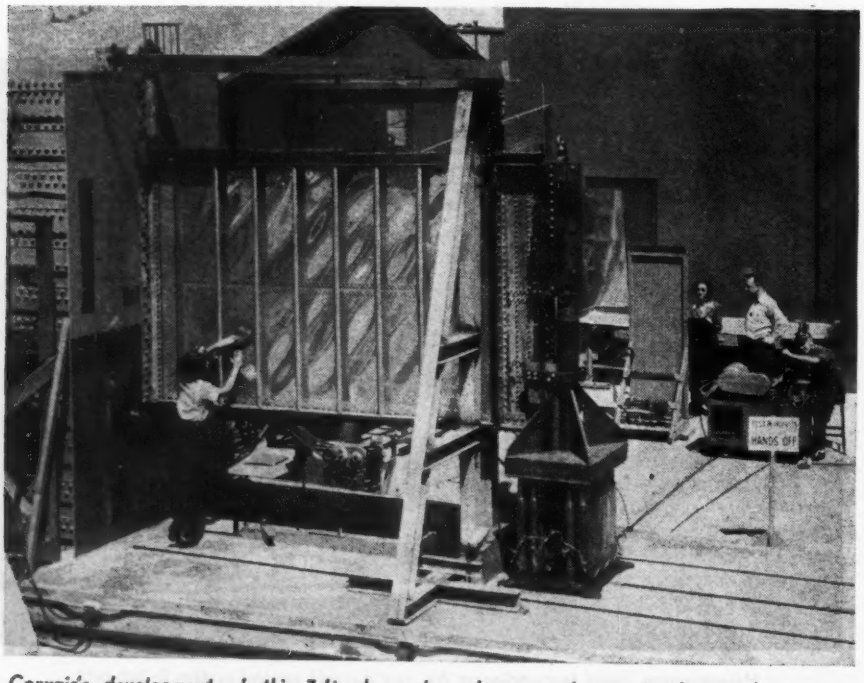


Left: On physical testing machines, Convair laboratory analyst makes both research and routine checks. Right: In Aluminum Co. of America laboratories, RCA electron microscope aids in micro-structure research. (Alcoa photo)

it, it isn't scientific any more." We find it has remained for engineering and economics to show the need for, and value of, industrial research. Approximately 60 yr. ago the opinion was expressed in Europe by many practical scientists, who had reviewed the trend of developments in their specific sciences, that the greatest advance in the future would take place in America. Although European countries stood in the forefront at that time, it was felt that conditions were such in America that we were destined to take the lead at a not too distant date in both industrial and scientific achievements.

This, prophecy has, to a large extent, been fulfilled. Witness the technological advances of the last decade in aircraft, radar, television, home, and automotive appliances. They indicate, in small part, the contributions in prewar and war years of our research and development laboratories. It was therefore no idle gesture that the Chicago Exposition of 1933 was dedicated to the "dependence of industry on scientific research".

From his favorable vantage point in surveying research progress, Dr. Weidlein,[1-2] director of the Mellon Institute of Industrial Research, some years ago said that "we are on the eve of events entirely different from the mere extension, refinement, and development of our present day scientific knowledge. It is not what we know that is so important. It is what we do not know. Most of what we know can be found in libraries, in the minds of people, and in processes as they exist today. But we have no conception of what a small percentage this knowledge comprises of what there is yet to know. There may be revealed at any time basic information that will keep us industrially busy for a great many years to come. The very fact that we have a great deal of trouble is the best indication of this lack of understanding."



Convair's development of this 7-ft. deep shear beam marks structural-research progress toward production of huge wing spars for great postwar "altiliners."

At the Cross Roads

Is there not a danger—with the present tremendous wartime "push" that is being given research and scientific investigations—in training a group of specialists in relatively unrelated fields and forgetting the less interesting but equally important phase of the interdependency of these experts, their control, closer organization, greater economy, etc.? Witness the dearth of written material on research organizations and the local nature of

the tried laboratory methods that would be of common knowledge to industry.

Having visited in the last few months many outstanding research and testing laboratories and numerous technical libraries, from Washington, D. C., to Los Angeles, Calif., to obtain opinions on the ever-increasing problems of test laboratory postwar planning, training and control of test engineers, research and test scheduling, etc., this writer has been increasingly impressed by the lack of factual written information. Each laboratory has its tried methods and shortcuts—but each technical group apparently takes little interest in the problems and solutions determined in neighboring research institutions.

Excellent contributions have been made by a few scientific leaders—such as Boyd,[I-1] Weidlein,[I-2] Hawkins,[I-3] Bichowsky,[I-4] Whitney,[I-5] Hirshfield,[I-6] Kettering,[I-7] and others—to integrate the fields of scientific research and testing insofar as the policies, standardization, and basic education are concerned; but the remarkable strides made in the last few years in laboratory administration and technical development have gone unrecorded.

It will be the writer's sincere attempt in this series of articles to discuss the viewpoints of the research engineer and technician, his laboratory, his training, and his problems, especially as they relate to the aircraft industry. Inasmuch as this discussion will comprise but one person's ideas, with such borrowed texts, maxims, and photographs as can be applied to the subject from current technical literature and from other laboratories, it is requested that technical and laboratory personnel sharing opposing or supporting viewpoints write the author, or better still, publish their ideas for general information, so that this present trend toward postwar economies, even to the radical curtailment of postwar developments and reduction of laboratory research facilities and personnel, can be publicly discussed before irreparable damage is done by industrial "top managements" not thoroughly conversant with the problems, policies, nor with the work of the modern test and research laboratories.

Kettering[I-7] once said, "We are reading the first verses in the first chapter of a book whose pages are infinite." Surely with such a future, industrial management can spend a few hours in pondering on the work and training of the laboratory scientist.

Early Research

Leonardo da Vinci, remembered as the artist of such marvelous masterpieces as the "Mona Lisa" and the "Last Supper", nevertheless had scientific visions far ahead of his time. Da Vinci's experimental explorations of things of nature have come down to us in the form of his log of scientific literature, accurately illustrated, totalling five thousand pages, and this from a scientific "dark age". How much more should today's and tomorrow's research men and women be able to accomplish in this present technological "golden era".

The scientific and engineering research future for such infant industries as aircraft development, electronics, television, etc., has barely been scratched, and new developments are made daily which are more breathtaking than marvels projected in the sketches drawn by Leonardo in the 15th century.

The Royal Society of London, founded in 1662, was one of the first organizations devoted specifically to the form of exploration which today is called research. Here are some of the subjects which were considered for investigation at one of earliest meetings of the Society:

"Experiments with wires of several matters of ye same size, silver, copper, iron, &c., to see what weight will breake them. . . Experiment concerning the force that presseth the aire into lesse dimensions; and it was found that twelve ounces did contract 1/24 part of Aire. . . Experiment to show how much aire a man's lungs may hold, by sucking up water into a separating glasse after the lungs have been well emptied of Aire. . . Experiment of Animal engrafting, and in particular of making a Cock spur grow on a Cock's head. . . Whether there bee any such thing as sexes in trees and other plants."

Research Mindedness

Everyone, no matter what his trade or calling, should understand research to the point of developing an experimental attitude toward life's problems. Kettering[I-11] has stated that "Research is a state of mind". This state of mind breeds progress. While it begets a questioning attitude on things as they are, it follows through with constructive ideas to make them better. Kettering further clinches this argument on progressive planning by stating "We should all be concerned about the future because we will have to spend the rest of our lives there."

A person's beliefs and his actions should not be allowed to rest lightly on mere opinion; they should be solidly grounded upon a base of verified fact. It is amazing how argumentative people become on matters of mere opinion and how quickly a man with spe-

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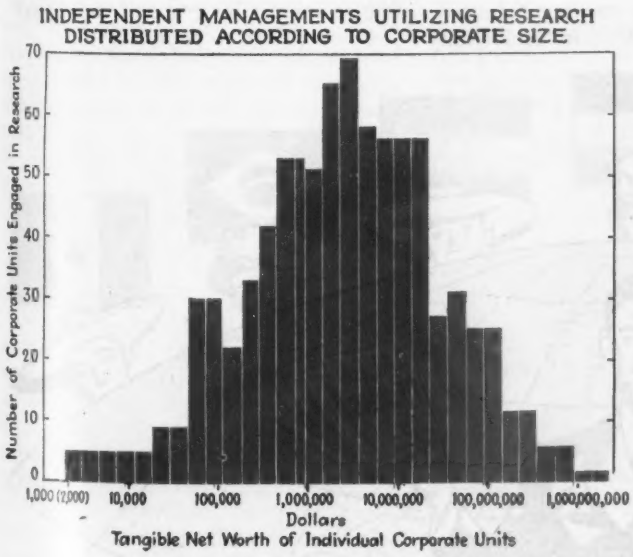
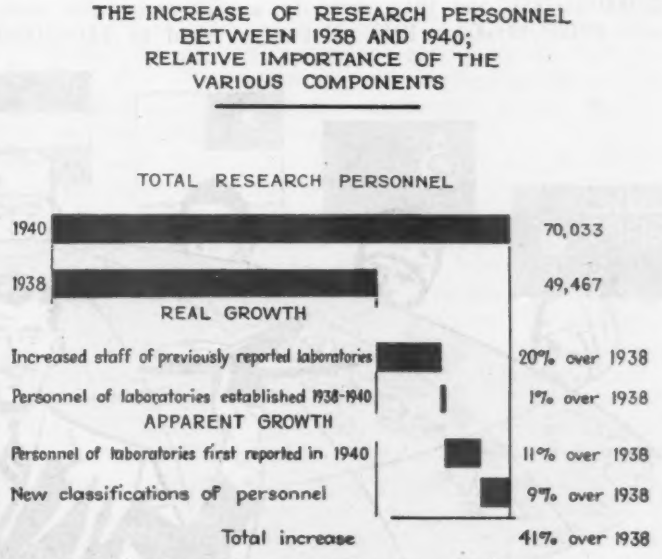




(Graphs from "Research—A National Resource," 1940 courtesy National Resources Planning Board)

Foreign Trade Offers A Key to Postwar Solvency

By **RAYMOND L. HOADLEY,** *Financial Editor, "Aviation"*

Huge trade balances and gold stocks held in the U. S. give export markets new postwar importance. But, says our financial editor, planning must have priority right now—if this trade, so vital for building the peace, is to get a true flying start . . . First article in a salient new series.

POSTWAR PROSPERITY? Or depression? Which will it be for the aircraft industry? The answer may be found in foreign trade.

Foreign holdings of gold and trade balances in the United States today exceed $20,000,000,000, or *four times* as much as they were at the end of World War I.

What does this mean to aviation? It means that foreign trade beckons every aircraft manufacturer who yearns for new markets to conquer. It holds forth the promise of export opportunities far beyond anything plane makers have ever dreamed of—but only if they start their planning now. Foreign markets have proved to be gold mines to the automobile trade in the past. These same markets, and many new ones too, now await the aircraft industry.

Even in 1928, the year before the crash, foreign holdings here were only $7,000,000,000, and they came to a mere $9,000,000,000 in 1940. Not only are balances here now above $20,000,000,000, they bid fair to rise several billion dollars more before the war with Japan runs its course.

Directly after World War I, our foreign trade, instead of declining as one might suppose, pushed on up to higher levels than ever before. In the two years 1919 and 1920, the supposedly impoverished war-wracked world bought goods worth $16,000,000,000 from us. Then, as now, there was a vast deferred demand from abroad. Then likewise as now, the United States was the only big industrial nation with unimpaired productive plant. The recovery of British industries took more than a year, and Continental industries even longer. They will take longer still this time.

Here the parallel ends. This time huge trade balances are held by nations which did not figure importantly in the 1919 foreign trade picture. There is India, with sterling balances equal to $4,000,000,000 in American dollars; Latin America, with $3,500,000,000 balances; and even China, with $1,000,000,000 right here in this country.

Not an aircraft-producing nation in the bunch. But they are all airminded.

In 1918 we were thinking mainly—when we thought of foreign markets at all—of such nations as industrialized France and Great Britain. French balances now run about $2,000,000,000, and Great Britain is today a debtor nation with neither the goods nor the cash to liquidate its debts to others.

The agricultural and mining nations are the new markets. They all want to industrialize. And the significant thing for the aircraft manufacturer is that each one of them places transportation right at the top of their postwar needs. That's what they will spend their present trade balances on. Of course they want to modernize and equip what railroads they have and add some more rail mileage where possible. But, for the most part, they plan to jump right from ox carts to aviation, skipping the railroad and automobile stages. Because of the vast distances to be surmounted they can't afford the modern intermediate transportation stages.

So it is transportation, machine tools, and agricultural implements that the governments of these nations are planning to import by grace of their swol-

(*Turn to page* 249)

No two ways about it—a really thriving personal plane business can't be built unless it's backed by a fast-clicking system for supplying replacements, accessories, and materials in "over the counter" style. Grounding of planes for lack of parts will quickly ground the business for lack of customers, if we insist on being—

"PLANE WISE—AND PART FOOLISH"

By JAMES A. WALES, JR.

ONE OF PRIVATE AVIATION'S worst prewar bugaboos was the wholly inadequate distribution of standard and manufactured parts, accessories, and raw materials. The airplane manufacturers were concentrating upon aircraft design and engineering, and that meant relegation of their parts-marketing activity to a second-fiddle category.

This had the unfortunate result of losing many a good customer. The more well-to-do a man is, the more service he has learned to expect. He does not want to wait a month or six weeks for a plane part which he needs today in order to fly to a distant city on an important business trip.

Some owners in this class, unwilling to give up the use of airplanes, have anticipated their requirements for parts and maintenance by acquiring and keeping on hand a stock of replacement items. In this way only have they been able to be certain of the constant availability of their aircraft at all times, barring any major damage from accident. During wartime, of course, this difficulty has been even more pronounced for the private flyer, and no remedy is in sight for the remainder of the war period.

Manufacturers of aircraft, engines, accessories, and raw materials will do well to give serious thought now to arranging constant and widespread availability of their products to their future customers. Any discussion of this subject is, of course, based upon hypothetical considerations, the most important of which is the reasonable supposition that the industry will enjoy wide public acceptance in the form of the purchase of large numbers of private airplanes.

Certain problems arise within industry circles which affect the distribution possibilities of various classes of "expendable" or replacement parts and materials. For example, is it reasonable to expect a dealer to stock manufactured parts for every model of plane which he sells as well as such standard parts as tailwheels, tires, inspection covers, etc.?

First, let us distinguish between the various types of items involved in the over-all problem. There are, generally speaking, four classes of items. We have designated them alphabetically as follows:

A—Component manufactured parts peculiar only to the particular make and/or model of airplane involved. These include such parts as fuselage, wings, tail surfaces, landing gear struts, cowling, instrument panel, engine mount, etc.

B—Standard parts made by manufacturers who do not produce assembled aircraft but whose products are essential to the operation of aircraft. In this group are such items as engines, propellers, wheels, brakes, tires, carburetors, standard instruments, some controls like throttle and heater controls, standard electrical equipment, hardware, etc.

C—Accessories not essential to basic airworthiness but which are desirable improvements and are called for by many purchasers. Included here are such things as radio receivers and

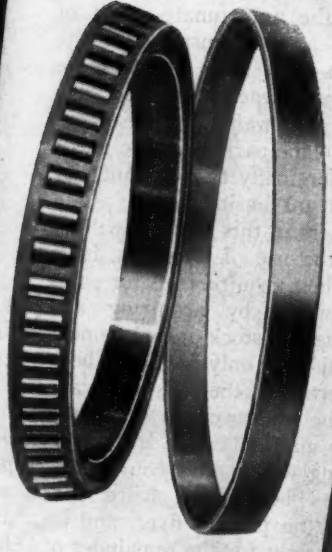
(*Turn to page* 264)

48 if by day 24 if by night

Equipped with Timken Bearings in its landing wheels, Consolidated Vultee's new post-war four-engined, 56,000-pound Liberator Liner will carry forty-eight daytime passengers . . . while its sleeper version will carry twenty-four.

Whether it's a luxury liner or a family-model helicopter, there are great aircraft advantages in Timken Bearings that cannot be duplicated. Aircraft engineers everywhere are making good use of the compactness, lighter weight, and maximum radial and thrust load-carrying capacity of Timken Bearings.

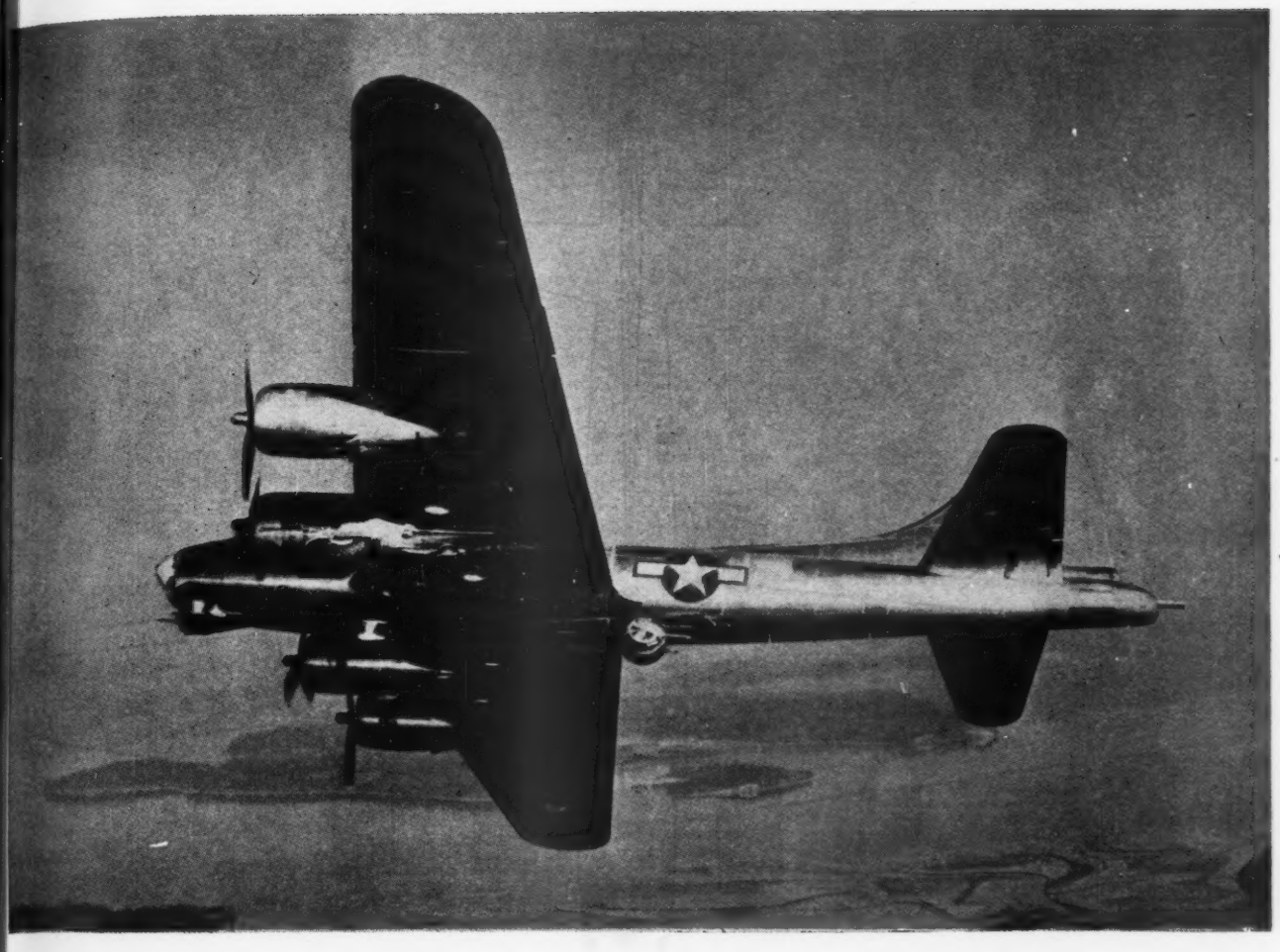
If these and other indispensable aircraft bearing features — such as economical maintenance and power conservation — can help meet your requirements, why not contact us? We'll be glad to make specific recommendations. The Timken Roller Bearing Company, Canton 6, Ohio.



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



DESIGN ANALYSIS OF

The Boeing B-17 Flying Fortress

By WELLWOOD E. BEALL
Vice-President in charge of Engineering, Boeing Aircraft Company

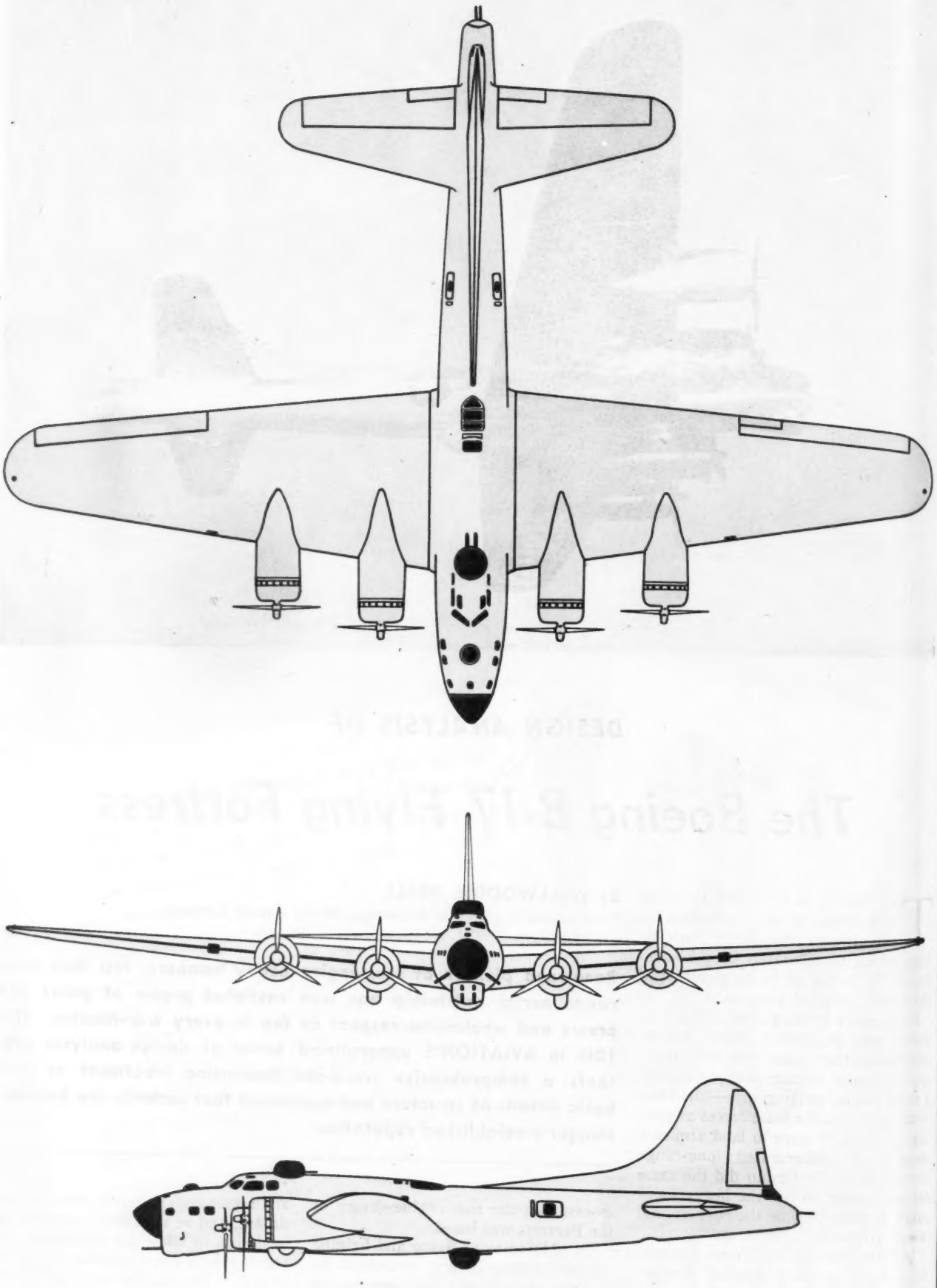
Renowned pioneer of four-engine heavy bombers, this fast long-range aerial battleship has won unstinted praise of pilots and crews and wholesome respect of foe in every war-theater. This 10th in AVIATION'S unparalleled series of design analyses presents a comprehensive word-and-illustration treatment of B-17 basic details of structure and equipment that underlie the bomber-slugger's established reputation.

THE Boeing B-17 Flying Fortress was designed as a battleship of the air—a stable sturdy platform from which to accurately drop bombs. It is daily living up to its picturesque name and designed purpose.

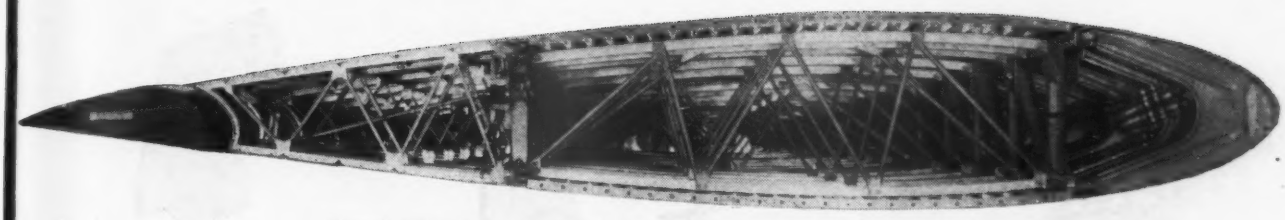
From every fighting front of the first global war in history come reports confirming that when this first four-engine, heavy bomber was conceived, a third major striking arm—airpower—was added to the basic forces of war. Just as artillery gave to land armies a weapon of concentrated long-range force, and the battleship did the same for sea power, so has the heavy long-range bomber become the core around which airpower is fashioned.

In 1934, Army Air Corps requests for bids on a "multi-engine" bomber that would fly 250 mph., land and stop within 2,000 ft., over a 50 ft. barrier, was interpreted by Boeing officials to mean two or more engines, and on that assumption, the four-engine design of the Fortress was based.

In addition to its flying and fighting characteristics, it was conceived by Boeing officials that the plane would have to be designed to permit manufacture in large quantities, provide for interchangeability of parts and service and repair under adverse wartime conditions, and be sufficiently conservative in design to allow for modification in keeping with ever-changing conditions of war. The rapidity with which the Fortress has changed is convincing proof of the wisdom of this early decision, but despite thousands of changes



Three-view aspect of Boeing B-17 Flying Fortress.



Inboard end view of outboard wing panel. Note attaching terminals at upper and lower points of spars, and corrugations under skin.

incorporated in the several modifications of the plane, the basic design and most of the major specifications still remain.

The B-17's structure is basically one in which skin and stiffening members, such as corrugated sheet, beams, angles, tubes, and rings of formed sheet carry the loads. Except for engine mounts, firewalls, landing gear, two tubes in each of the forward and aft walls of the bomb bay, and other miscellaneous alloy steel fittings, the airplane is structurally constituted of 24ST and 24ST Alcald.

The wing has a span of 103 ft. 9.38 in.—same as the original Fortress. The airfoil section combines NACA 0018 at the root with NACA 0010 at the tip. Wing area is 1,420 sq. ft. and the root chord is 228 in. Tip chord is 106.7 in. Taper ratio is 2.34:1, incidence 3½ deg., dihedral 4½ deg., and sweepback of the

FUNDAMENTAL DESIGN INFORMATION

General

Over-all length (max.)	74′ 8.90″
Height (max.) (tail in taxi position)	19′ 1″
Span (max.)	103′ 9.38″
Fuselage height (max.)	103″
Fuselage width (max.)	90″
Load Factor (ultimate)	4
Design gross weight (less bombs)	38,200 lb.
Recommended takeoff weight, over	60,000 lb.

Wing Group

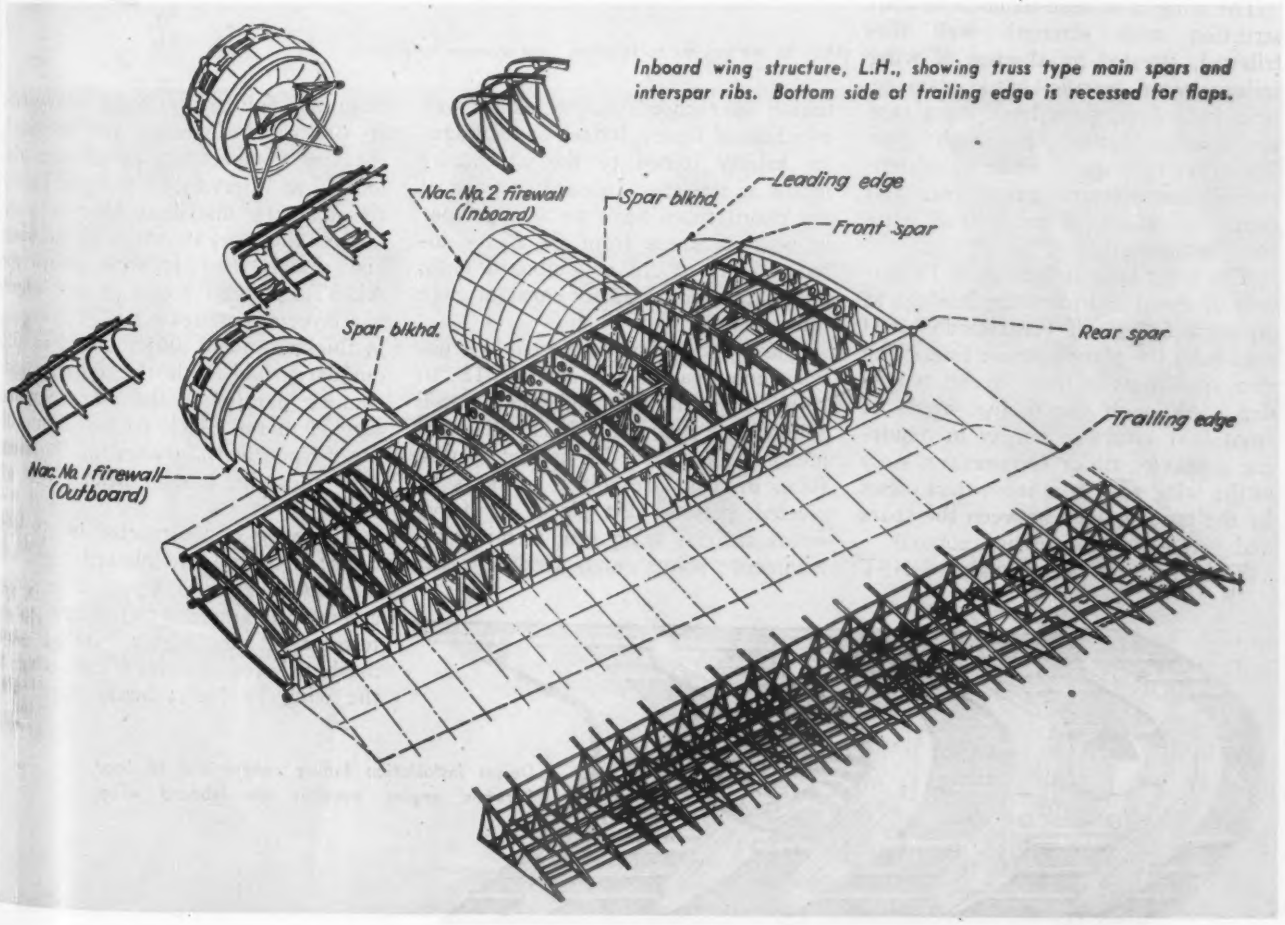
Airfoil section, root	NACA 0018
Airfoil section, tip	NACA 0010
Wing area	1,420 sq. ft.
Span	103′ 9.38″
Root chord thickness (max.)	41.06″
Root chord length	228.00″
Tip chord length	107.00″
Taper ratio (root chord/tip chord)	2.43:1
Angle of incidence	3.5 deg.
Dihedral	4.5 deg.
Sweepback (L.E.)	8.25 deg.
Maximum rib spacing	1′ 6″
Spar locations (front)	15% chord
(rear)	60% chord
Aspect ratio	7.58
Mean aerodynamic chord length	177.5″
Location relative to L. E. root chord, horiz. 30.3″, vert.	14.747″

AILERONS

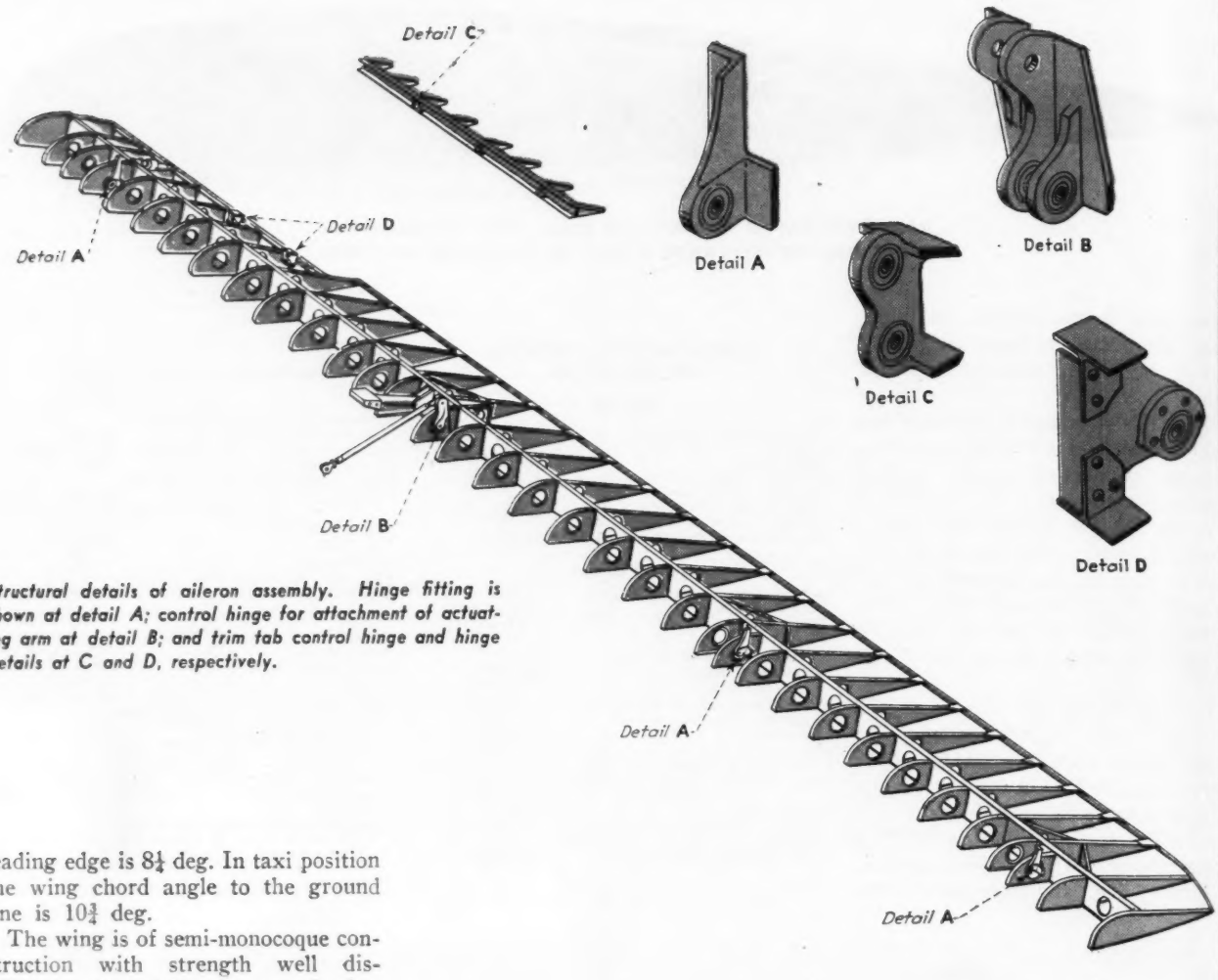
Area to hinge line (including tab)	60.2 sq. ft
Chord	26.25″
Span	229.87″
Distance from plane of symmetry to centroid of aileron area	38′ 10″
Angular movement (up or down)	12 ± 1 deg.
Type of balance	Frise
Hinge centerline (at outboard hinge)	21.4% of chord
(at Inboard hinge)	27.3% of chord
Tab area (L. aileron)	2.64 sq. ft.
Tab chord	8.09″
Tab span	55.10″
Tab angular movement (up or down)	15 ± 2 deg.

Flaps

Area (total)	139.1 sq. ft.
Span (each)	24′ 4 15/16″
Chord	34 13/32″
Movement	45 ± 2 deg.
Effect on aerodynamic characteristics:	
Decrease landing speed	9 mph.
Increase lift coefficient from 1.6 to 2.10 at 1.2 stalling speed.	
Increase drag coefficient from .1095 to .1775 at 1.2 stalling speed.	
Increase gliding angle from 5 deg. 39 min. to 7 deg. 20 min. at 1.2 stalling speed.	



Inboard wing structure, L.H., showing truss type main spars and interspar ribs. Bottom side of trailing edge is recessed for flaps.



Structural details of aileron assembly. Hinge fitting is shown at detail A; control hinge for attachment of actuating arm at detail B; and trim tab control hinge and hinge details at C and D, respectively.

leading edge is 8¼ deg. In taxi position the wing chord angle to the ground line is 10¾ deg.

The wing is of semi-monocoque construction with strength well distributed, attested by absence of wing failure after terrific battle damage. The two main spars have truss type construction rather than web type. The truss type spars, while more difficult to manufacture, are lighter and contribute about 30 percent of wing bending-strength.

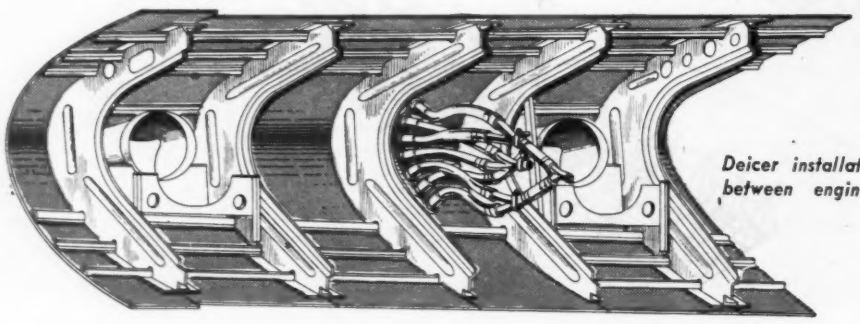
The front spar is located at 15 percent of chord and joins the fuselage at an angle 6 deg. off (rearward) of 90 deg. from the plane's center line. The rear spar joins at the conventional 90 deg. Although the 6 deg. angle of front spar incurs a penalty in requiring a heavier rib or compression strut at the wing root, it is more than offset by the space gained between the spars and straightline spanwise contour.

The truss type spars consist of 24ST tubing spar chords connected by web members of square, barrel, or rectangular tubing joined to the chords by means of gussets. Inboard sections of the chord tubes have an inside taper in wall thickness from .54 at the inboard ends to .13 at outboard ends. Outboard sections are of constant gage square tubing.

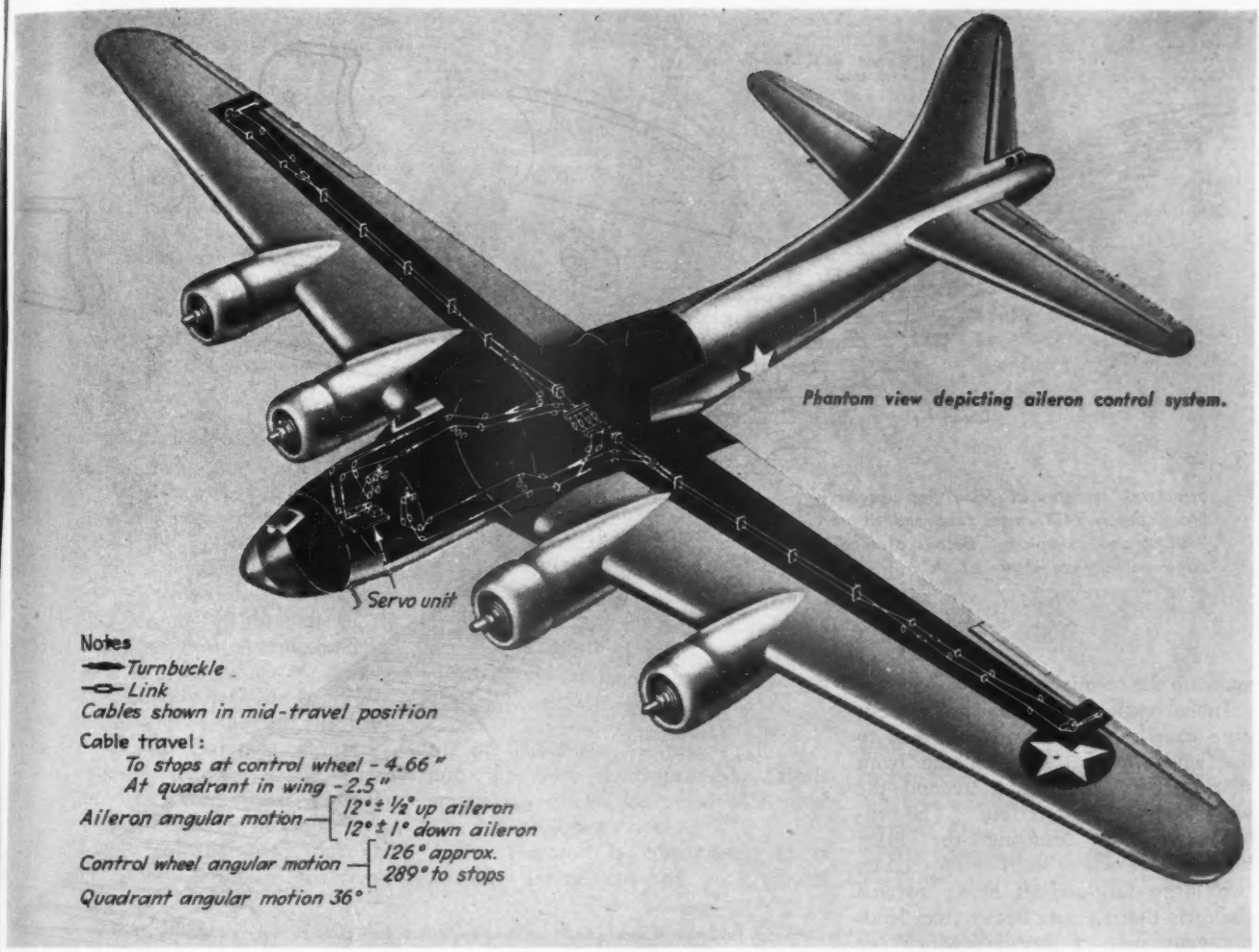
The two spars are connected by truss type interspar ribs, spaced 15 to 18 in. apart. Ribs are built up of 24ST channel chords and tubular diagonal members attached by gusset plates. Ribs, in turn, are joined to spars by riveted gussets. At places of heavy stress such as wing root terminal attachment points and landing gear mounting points, unusually heavy ribs or compression struts are provided. Heavier compression struts are also located at intervals among the lighter ribs to better distribute torsion.

Over the truss structure of the wing, and attached to it with skin type A17ST and 24ST rivets, $\frac{3}{16}$ and larger, is a layer of corrugated 24ST, ranging in thickness from .064 inboard to .016 outboard, laid with the corrugations running parallel to the rear spar and riveted to the 24ST Alclad skin with flush type rivets forward of the front spar and with brazier head rivets aft of that line.

The wing is constructed in six sections: right and left inboard, right and left outboard, and tips. The entire assembly is attached to the fuselage by terminals of highly heat-treated machined-steel forgings connected to the wing by bolts; heavy taper pins

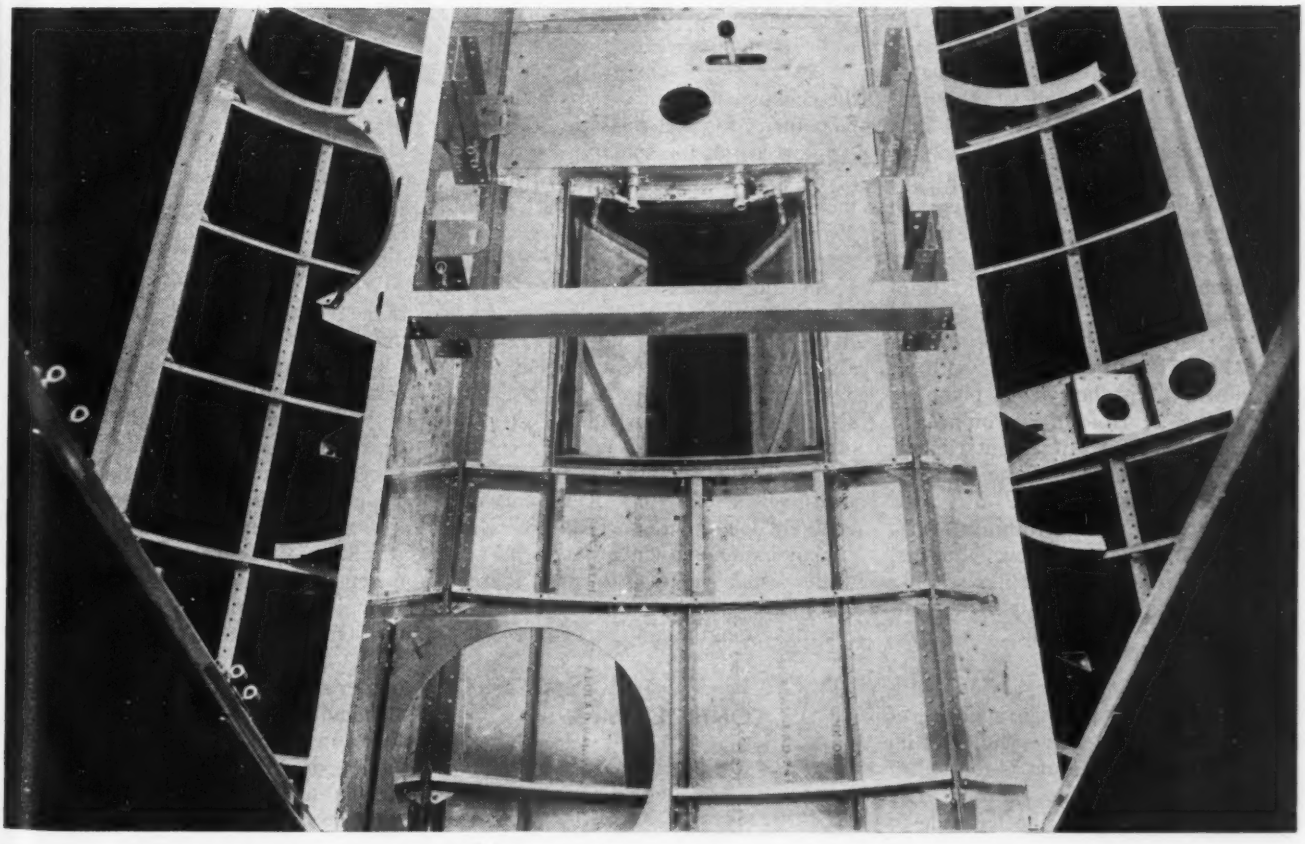


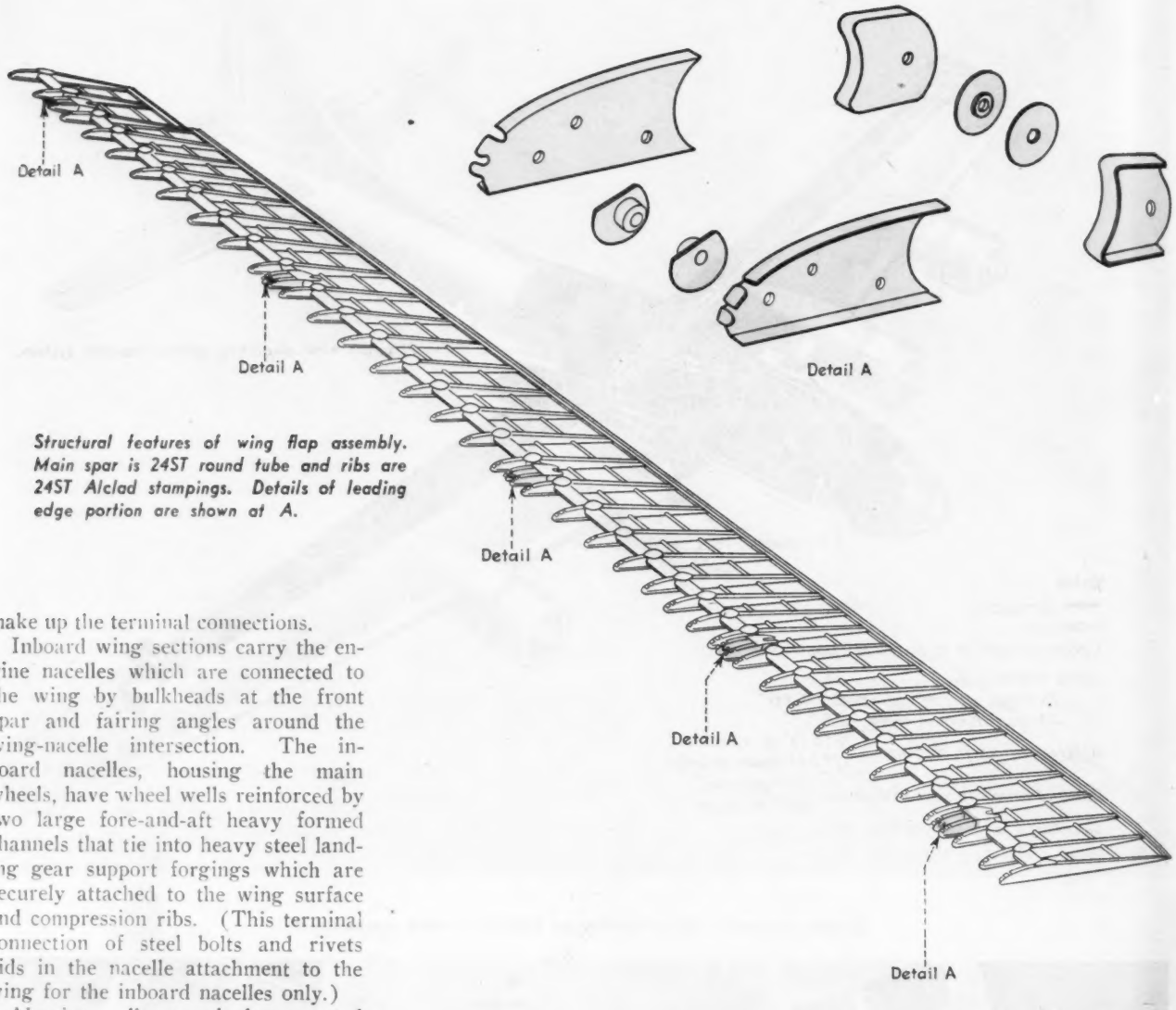
Deicer installation tubing connections to boot between engine nacelles on inboard wing.



Phantom view depicting aileron control system.

Details of camera well installation at bottom of radio compartment.





Structural features of wing flap assembly. Main spar is 24ST round tube and ribs are 24ST Alclad stampings. Details of leading edge portion are shown at A.

make up the terminal connections.

Inboard wing sections carry the engine nacelles which are connected to the wing by bulkheads at the front spar and fairing angles around the wing-nacelle intersection. The inboard nacelles, housing the main wheels, have wheel wells reinforced by two large fore-and-aft heavy formed channels that tie into heavy steel landing gear support forgings which are securely attached to the wing surface and compression ribs. (This terminal connection of steel bolts and rivets aids in the nacelle attachment to the wing for the inboard nacelles only.)

Aluminum alloy terminals connected by taper pins are used at terminal connections between inboard and outboard wing panels. The wing tip has four terminal points of welded steel or magnesium alloy, and is secured to the outboard wing panel by means of steel bolts.

Ailerons are the conventional fabric-covered D-nose type having an area of 60.2 sq. ft. to the hinge line, and an angular movement of 12 deg. both up and down. Distance from plane of symmetry to centroid of aileron area is 38 ft., 10 in. The hinge centerline is located at 21.4 percent of the chord at the outboard hinge and at 27.3 percent of the chord at the inboard hinge. Mass balancing of the aileron is accomplished by a single weight on an arm extending forward from the aileron spar and concealed entirely within the wing contour.

The left wing only is provided with a trim tab. The tab has an area of 2.64 sq. ft., angular movement both up and down of 15 deg., and is located at the inboard end of the aileron. The tab control knob is on the left side of the cockpit and requires approximately 3.76 turns for full operation.

Flaps are of the split type with span of 24 ft. $4\frac{5}{16}$ in. each, a chord of $34\frac{3}{32}$ in., and a total area of 139.1 sq. ft. Maximum movement is 45 deg. which increases the maximum lift coefficient of the entire plane from 1.53 to 2.0 and increases the drag coefficient from .1095 to .1775 at 1.2 stalling speed. It also increases gliding angle from 5 deg. 39 min. to 7 deg. 20 min. at 1.2 stalling speed, and decreases landing speed 9 mph. Main spar of flap is a 24ST round tube, $2\frac{1}{2}$ in. in diameter, selected for efficient carrying of torsion and bending loads. Flap ribs are 24ST Alclad stampings which have stiffeners (intercostals) clipped to them, thereby eliminating notches in ribs and so retaining strength.

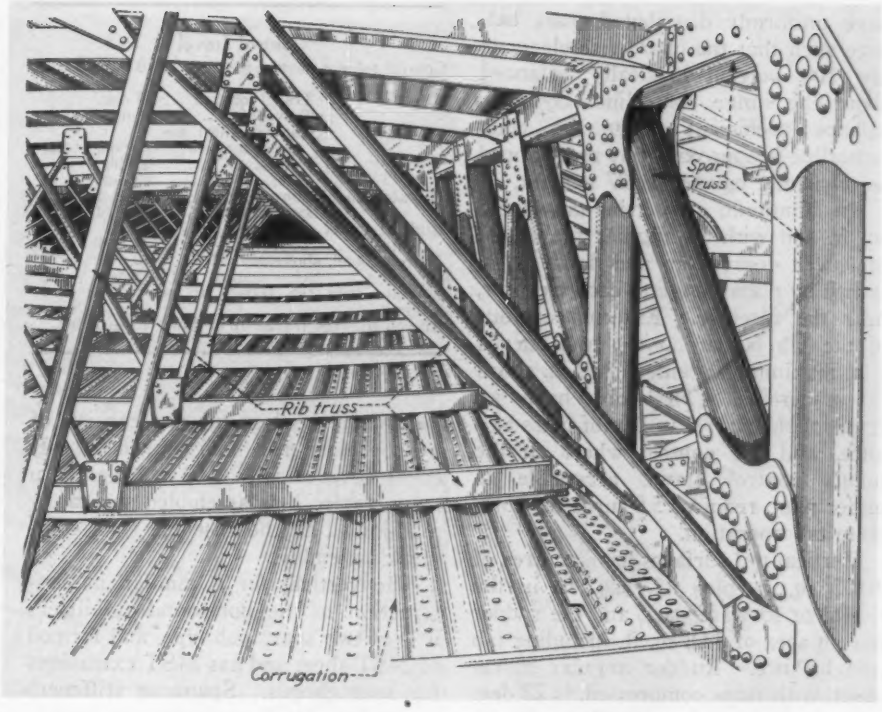
CONTROL Cable Sizes

Rudder (single)	3/16" diam.
Elevator (double)	3/16" diam.
Ailerons (single)	3/16" diam.
Tabs (elevator, ailerons) (single)	3/32" diam.

Flaps are actuated by means of interchangeable, irreversible screw and nut units operated through torque tubes, located adjacent to the rear wing spar, and powered by an electric motor. They can be raised or lowered at 126 mph. in 15 to 30 sec.

Greatest single factor contributing to the Fortress' famed stability is the unusually large empennage. Although it was known at the time the original Fort was designed, that a large vertical fin was essential to stability, and the original fin design was somewhat larger than the then accepted practice, it was puny by comparison with the present installation.

Some of the design features of the present dorsal fin were dictated by incorporation, in 1940, of a tail gun position, while other features were the result of redesign to achieve still greater stability. Pilots report stability so complete that the airplane can be flown on tabs alone without using the rudder, or with ailerons and elevators without using the rudder, or without resetting of trim tabs.



Closeup of internal wing structure showing attachment details of spar truss, rib truss, and corrugations.

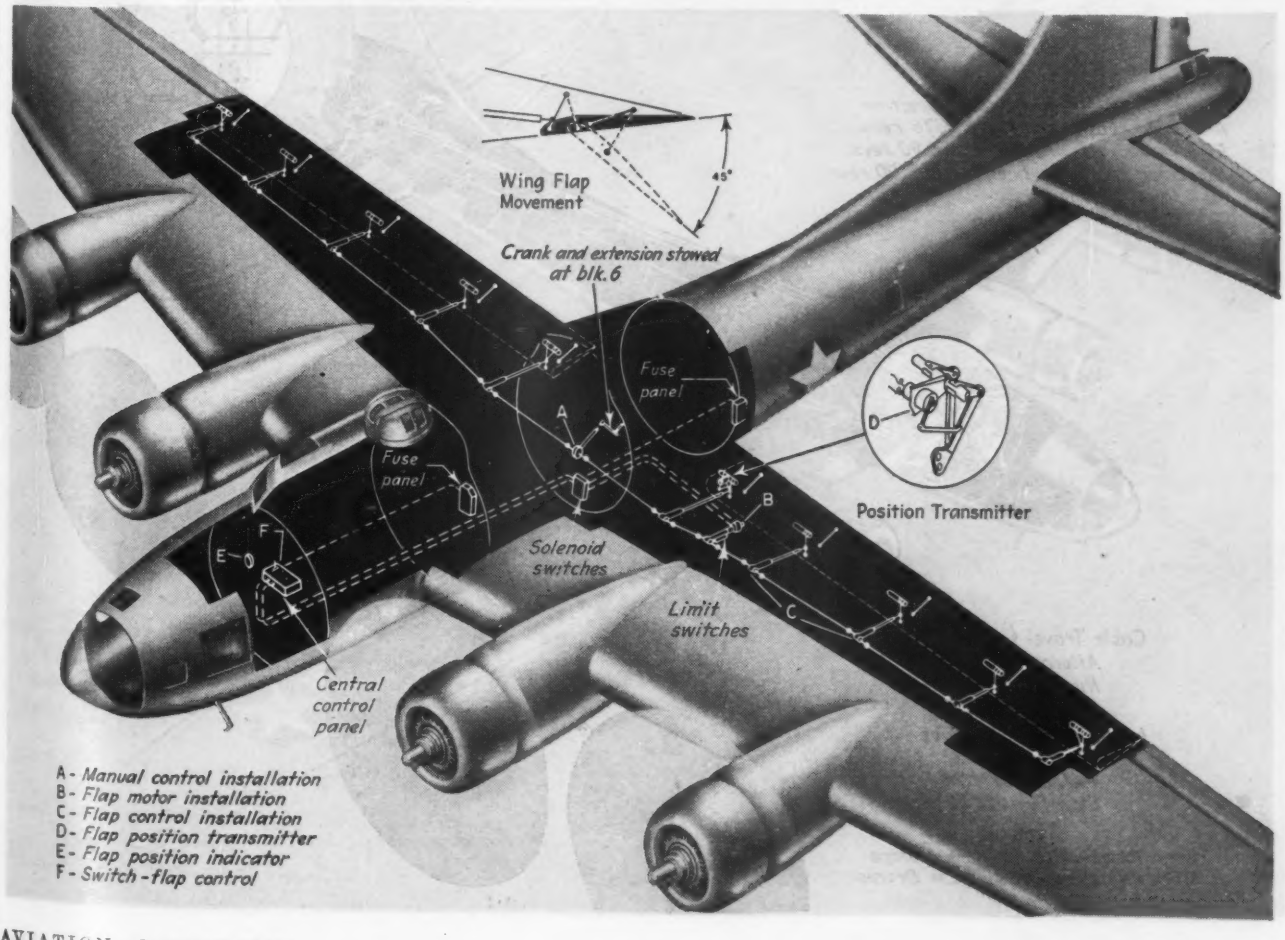
Horizontal tail surfaces have an area of 331.1 sq. ft., span of 43 ft., maximum chord of 125 in., and a distance of 451 in. from normal c.g. to ¼ maximum chord point. The span places the tip of the stabilizer almost directly aft of the outboard engine nacelle.

The stabilizer has an area of 250.6 sq. ft. and is set at 0 deg. relative to longitudional axis. It is of two-spar construction with web-type spars made of 24ST web sheet and extruded spar chords, rolled 24ST spanwise stiffeners reinforcing interspar skin, and hydropressed 24ST ribs. The front spar extends 230 in. to within 8 ft. of tip end. The longer rear spar extends to the tip joining point.

From the point where the front spar stops to the end of the tip, the leading edge and rear spar take over as the shear-carrying structure. The Alclad horizontal stabilizer has skin lap joints. Attachment is by flush type rivets forward of the front spar and modified brazier head skin type rivets aft of that line. Beams are I type, and ribs are hydropressed. Both stabilizer panels are removable, and attachment fittings are steel.

The elevator is constructed of a metallic frame covered with doped fabric, and is controlled by a short torque tube. Area is 115 sq. ft. including tabs and balance. Angular movement is 23 deg. up and 14 deg. down. Thirty percent of elevator area is ahead of the hinge line. Elevators

Phantom view of wing flap actuating system. Inset shows transmitter mechanism for position indication at E.



have uniformly distributed mass balance such that the chordwise elements are 100 percent statically balanced about the hinge centerline. Dynamic balance coefficient about the body centerline is approximately zero. Chord aerodynamic balance is 27 percent.

An aluminum alloy trim tab of 5.6 sq. ft. and with an angular movement of eleven degrees up and down is attached by piano hinge to each elevator, near the fuselage. External contour of the tab is flat on top and curved $\frac{3}{4}$ in. maximum at center of 11 in. chord on underside. The tabs have an irreversible control in lieu of mass balance, and the control wheel on the pilot's control stand, accessible to either pilot, requires 5.9 turns for complete tab operation.

Vertical tail surfaces have an area of 100.5 sq. ft. plus 42.4 sq. ft. in the dorsal or forward part, and the rudder has an area of 38.8 sq. ft. including tab and balance. Rudder angular movement, with stops compressed, is 22 deg. right and same left, with 21 deg. available using cockpit control.

The dorsal portion is an integral part of the fuselage top and consists of hydropressed ribs and extruded stiffeners covered with 24ST Alclad. In manufacture it is assembled separately and joined to the fuselage as a completed assembly.

Control Travel

Control column neutral position	10 deg. 30 min. f'w'd
Travel forward	13 deg.
Travel aft	18 deg. 30 min.
Control wheel angular motion	126 deg. total
Right	63 deg.
Left	63 deg.
Elevator travel, above neutral	23 ± 1 deg.
Below neutral	14 ± 1 deg.
Rudder travel right and left of neutral	22 ± 2 deg.
Aileron travel, above neutral	12 deg.
Below neutral	12 deg.
Elevator trim tab travel, up or down	11 ± 2 deg.
Aileron trim tab travel, up or down	15 ± 2 deg.

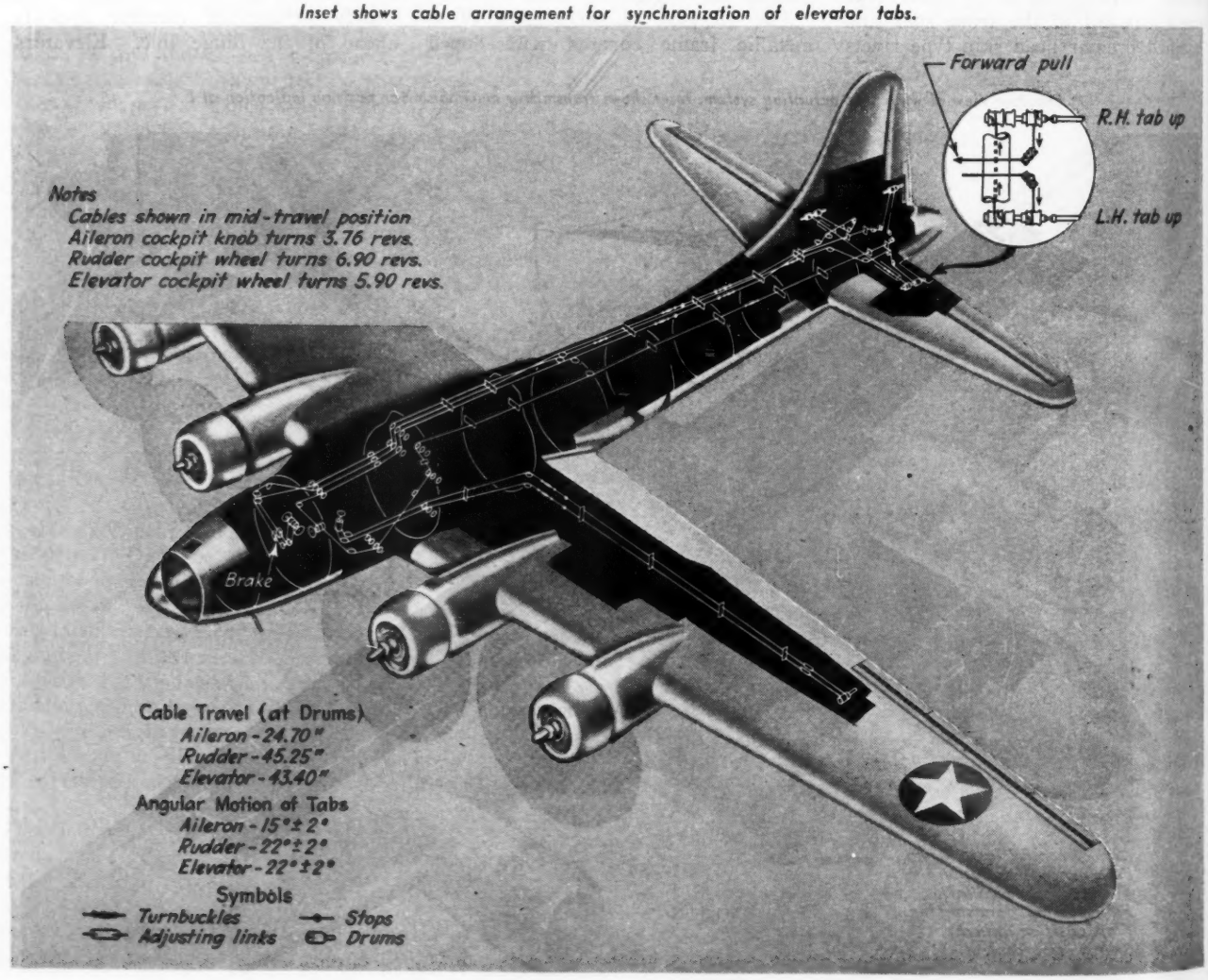
The vertical fin is similar in construction to the horizontal stabilizer; it is of two spar, web type, and formed of 24ST sheet and has 24ST extrusions for spar chords. Spanwise stiffeners are rolled 24ST and ribs are hydropressed stampings of 24ST sheet stock. A portion of the fin load is carried forward through the dorsal section.

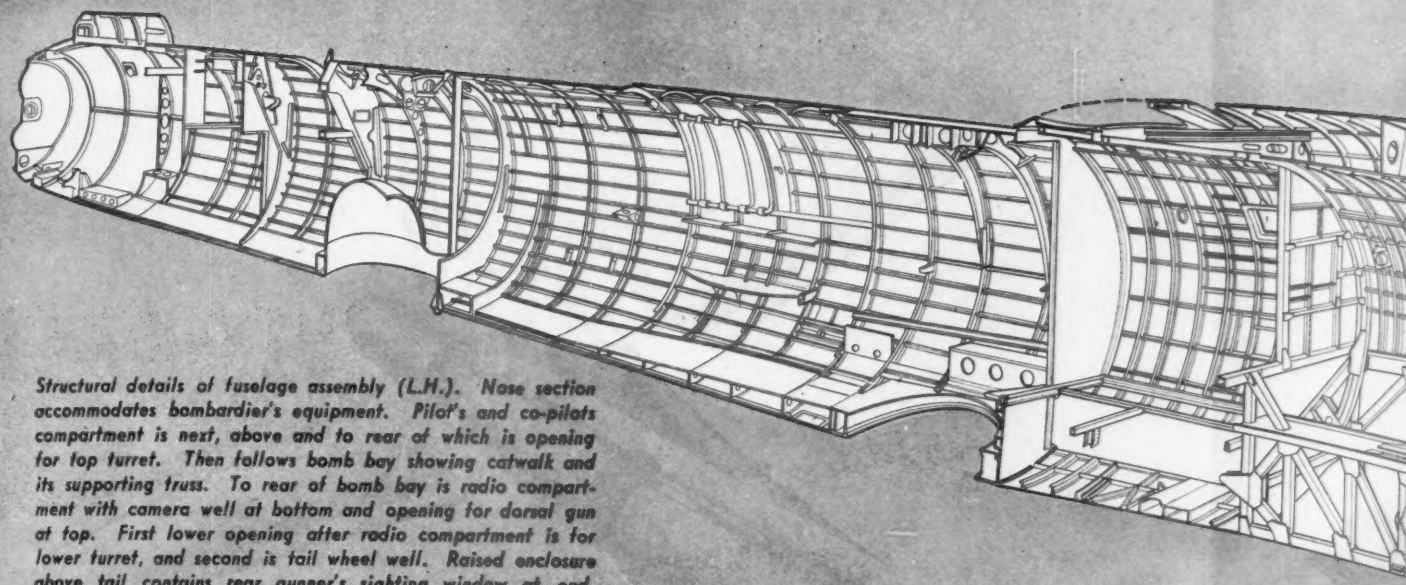
The rudder has a metal framework with hydropressed nose ribs forward, and tail ribs aft, of the spar. The entire frame is covered with highly processed fabric which, when properly applied, provides a control surface having a minimum tendency to flutter because of dynamic air forces. Actuation is about three hinge points by a rudder torque tube controlled through a cable system from the cockpit.

The rudder has a uniformly distributed mass balance such that the chordwise elements are 100 percent statically balanced about the hinge centerline, and the dynamic balance coefficient about the body centerline is approximately zero. Chord aerodynamic balance is 25 percent.

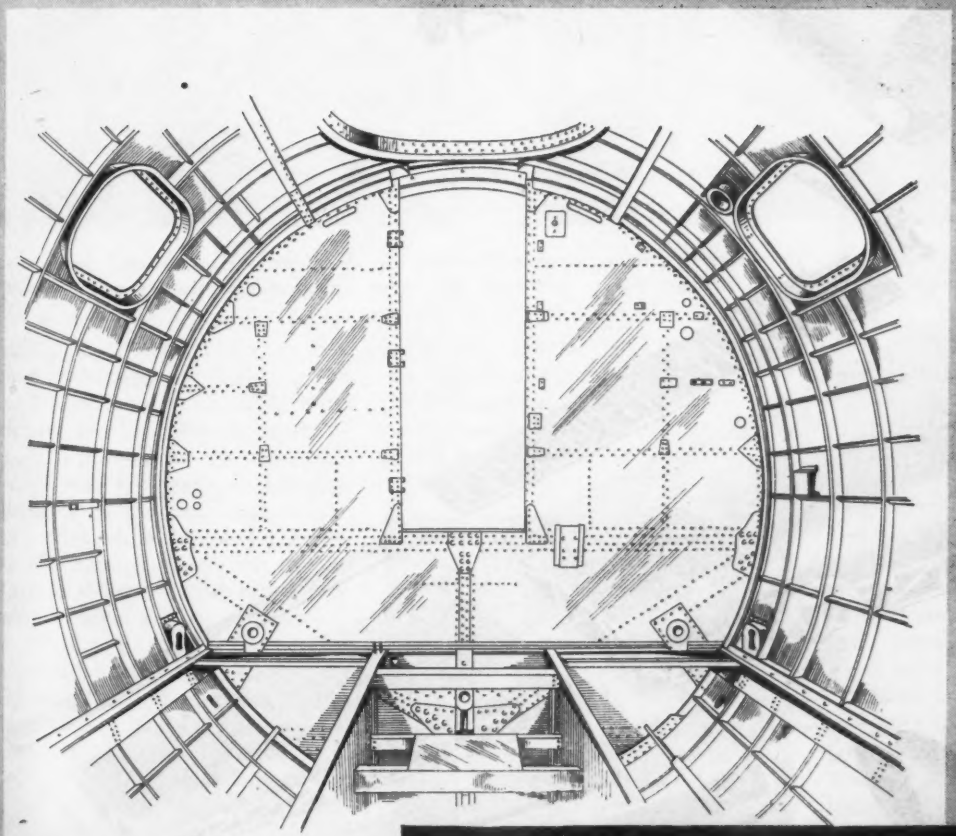
The trim tab is aluminum alloy with an area of 3.4 sq. ft. and is installed at the lower trailing edge. It has irreversible controls with the control wheel aft of the control stand in the pilot's cockpit. Approximately 6.9 turns of the wheel are required for complete tab operation. Angular movement is 22 deg. each way.

Phantom view of aileron, rudder and elevator trim tab control systems. Inset shows cable arrangement for synchronization of elevator tabs.

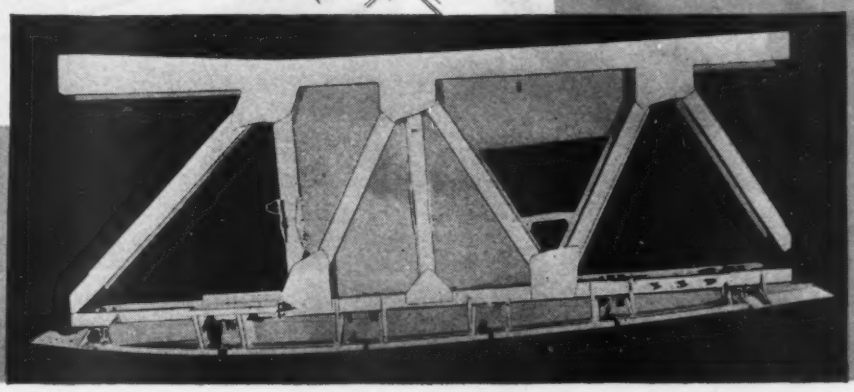




Structural details of fuselage assembly (L.H.). Nose section accommodates bombardier's equipment. Pilot's and co-pilots compartment is next, above and to rear of which is opening for top turret. Then follows bomb bay showing catwalk and its supporting truss. To rear of bomb bay is radio compartment with camera well at bottom and opening for dorsal gun at top. First lower opening after radio compartment is for lower turret, and second is tail wheel well. Raised enclosure above tail contains rear gunner's sighting window at end.

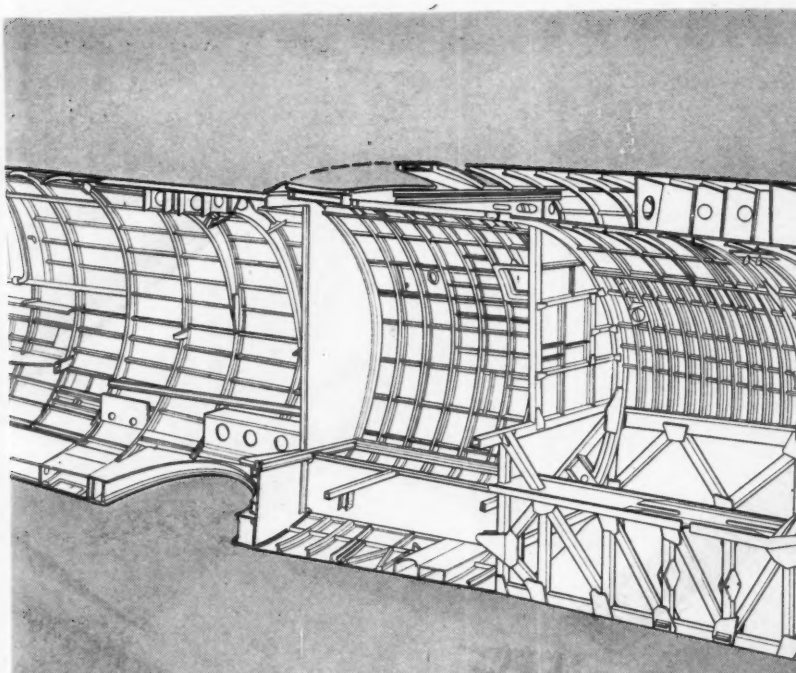


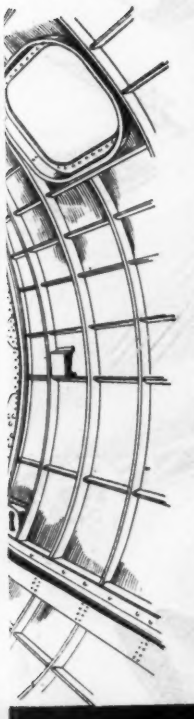
Typical fuselage structure showing bulkhead, longerons (on either side of top opening), and circumferential and longitudinal stiffeners. Beams in center foreground are floor supports, with camera well between.

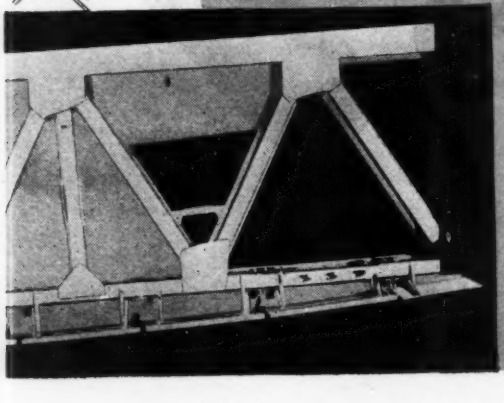


Body compression strut located in bomb bay. Doors are attached to hinge supports on bottom member.

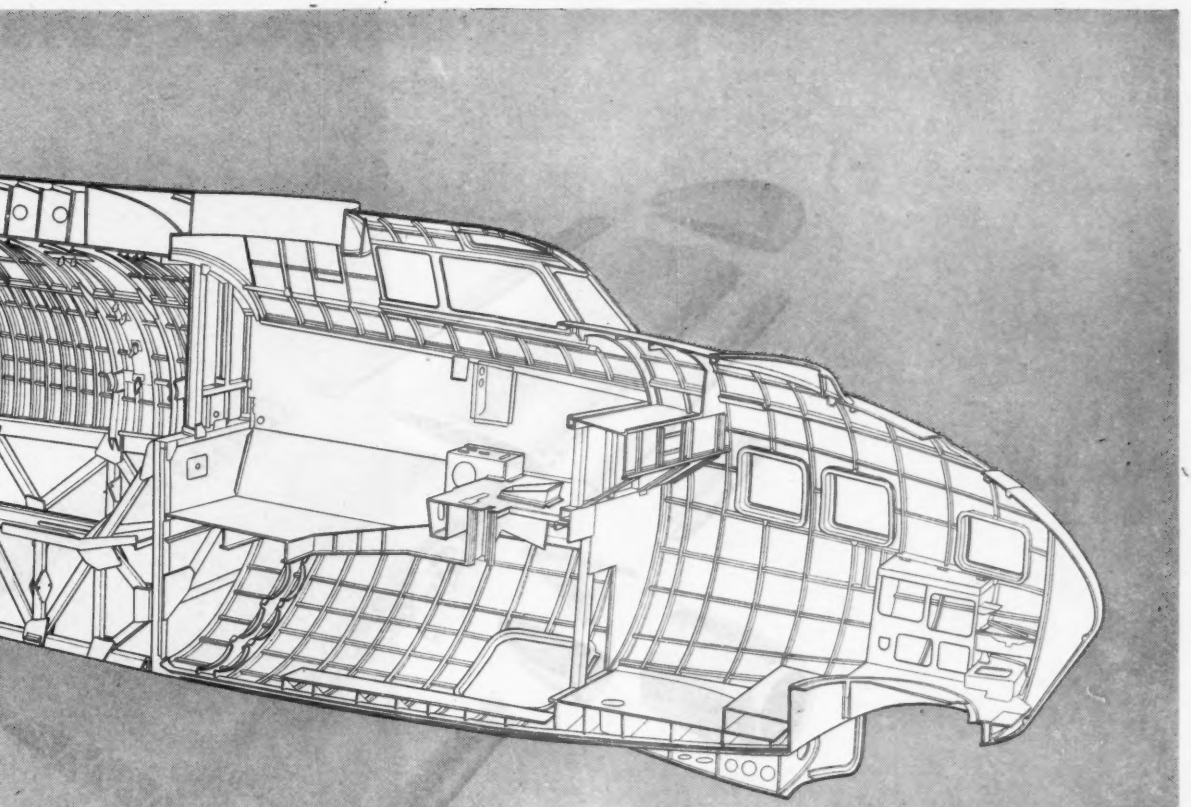
Interior view center is adj covered with top enclosure

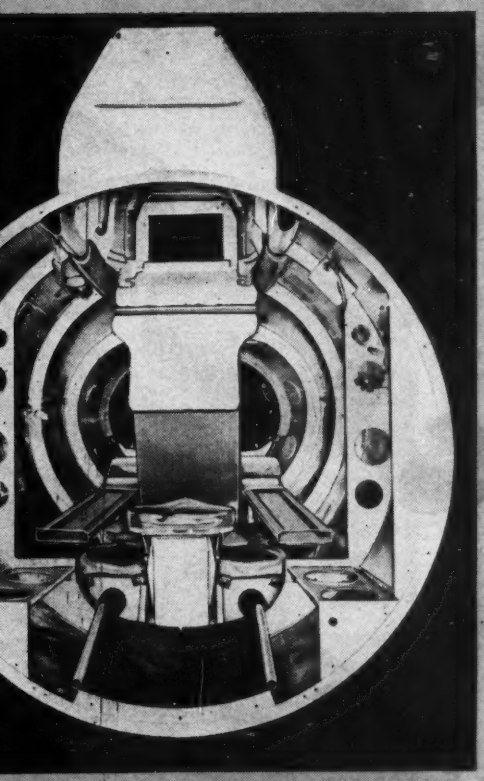




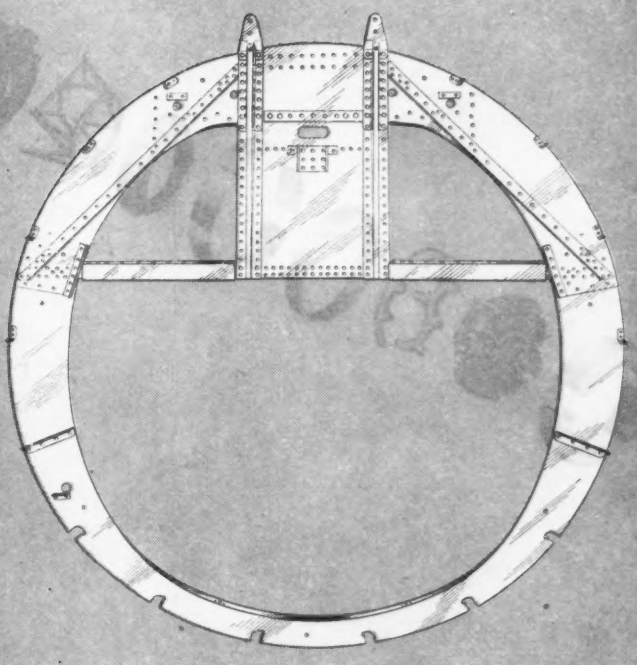


Interior view of tail gu
center is adjustable seat
covered with rubber shoc
top enclosure. Cartridg

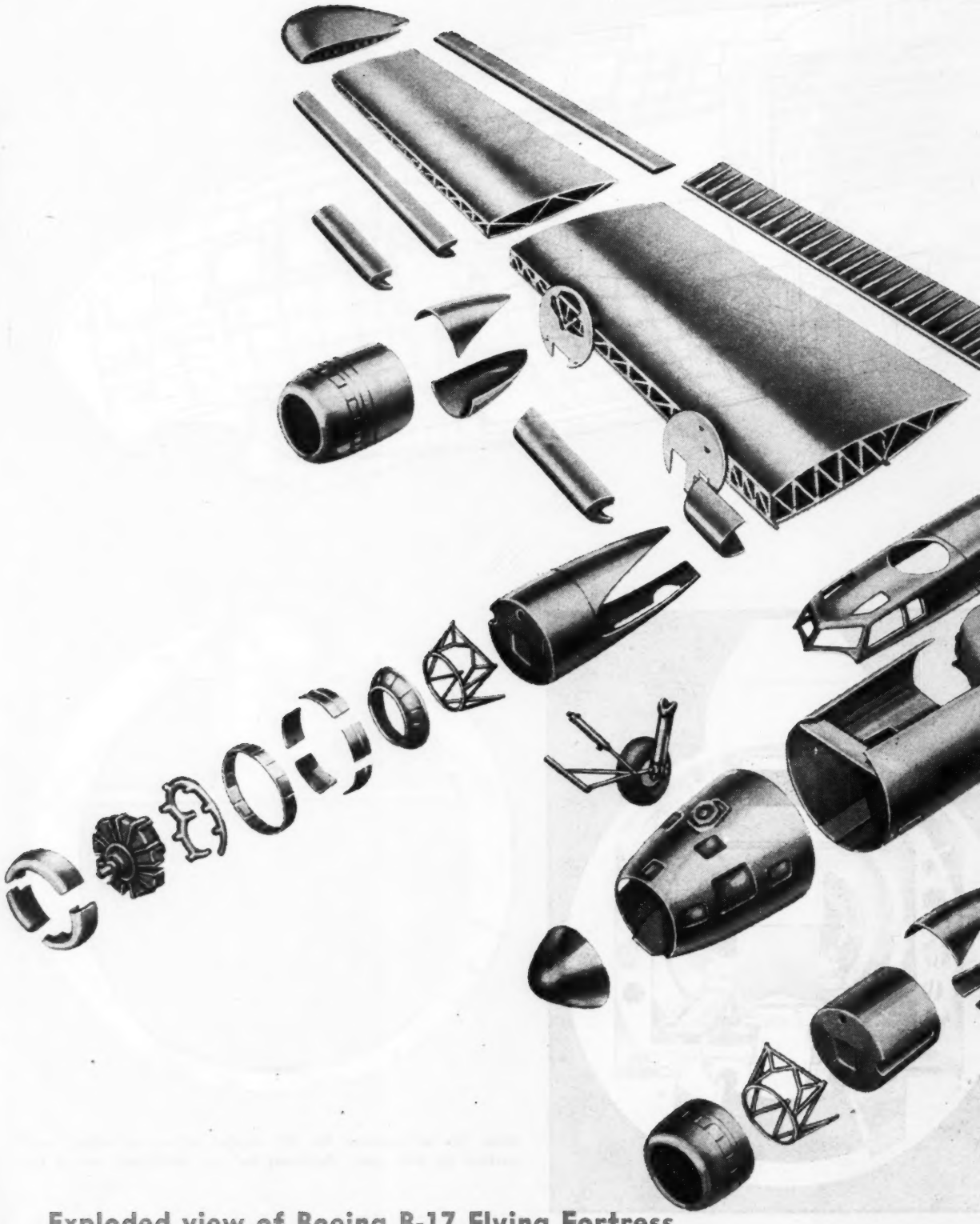




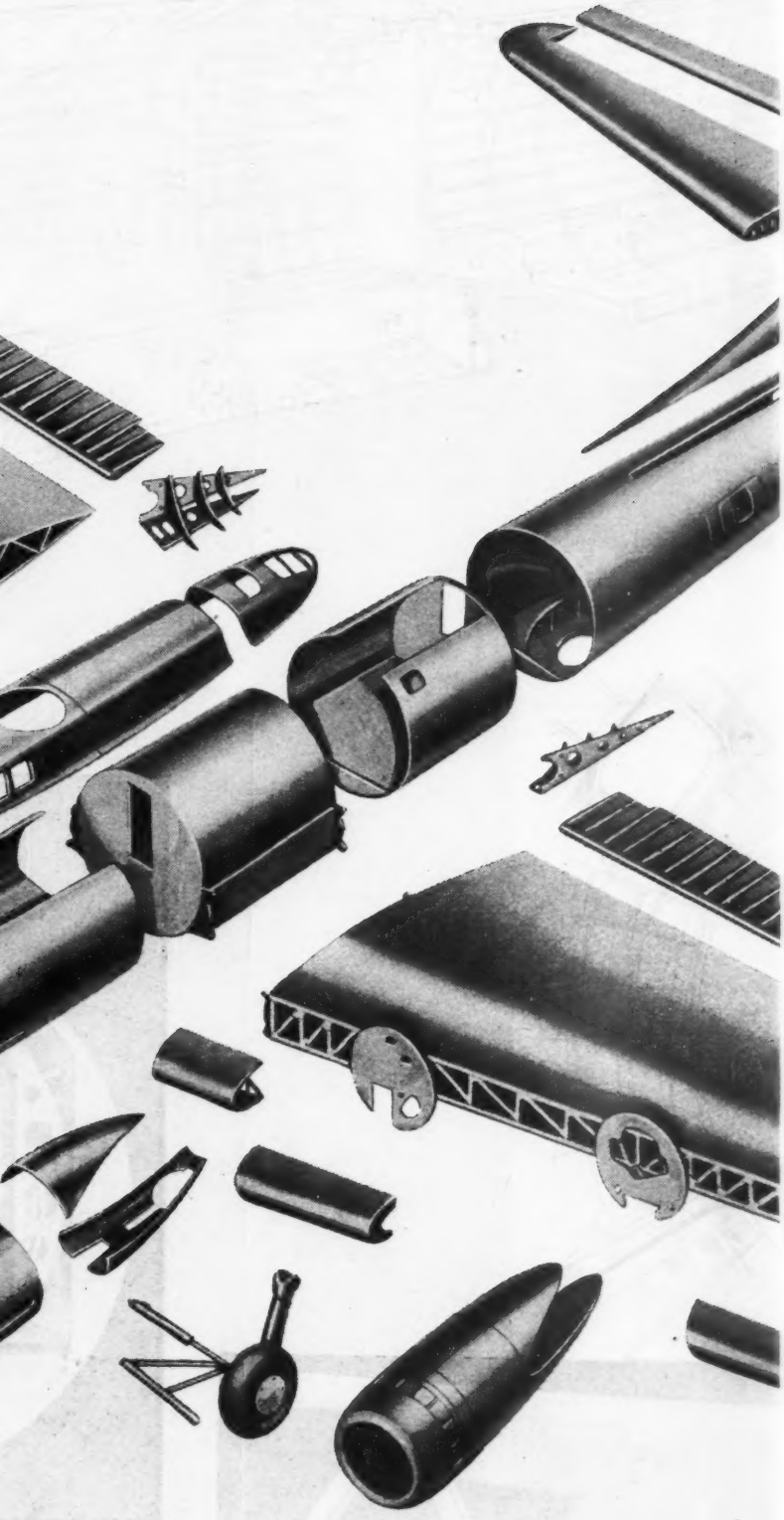
of tail gun emplacement aft of bulkhead 11. In stable seat behind armor plate with upper portion ubber shock pad. Bulletproof window is at end of Cartridge chute is seen at either side of seat.

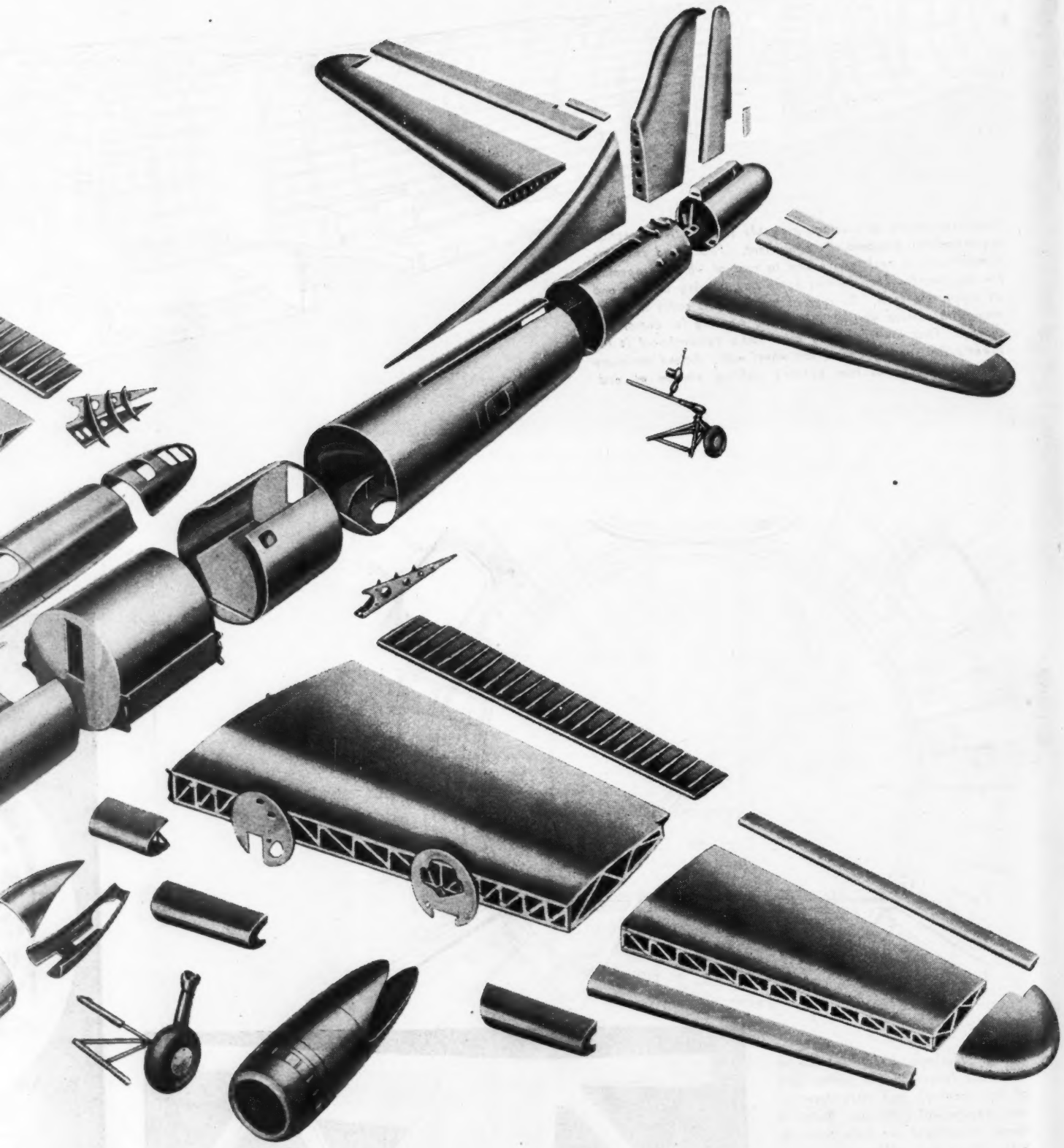


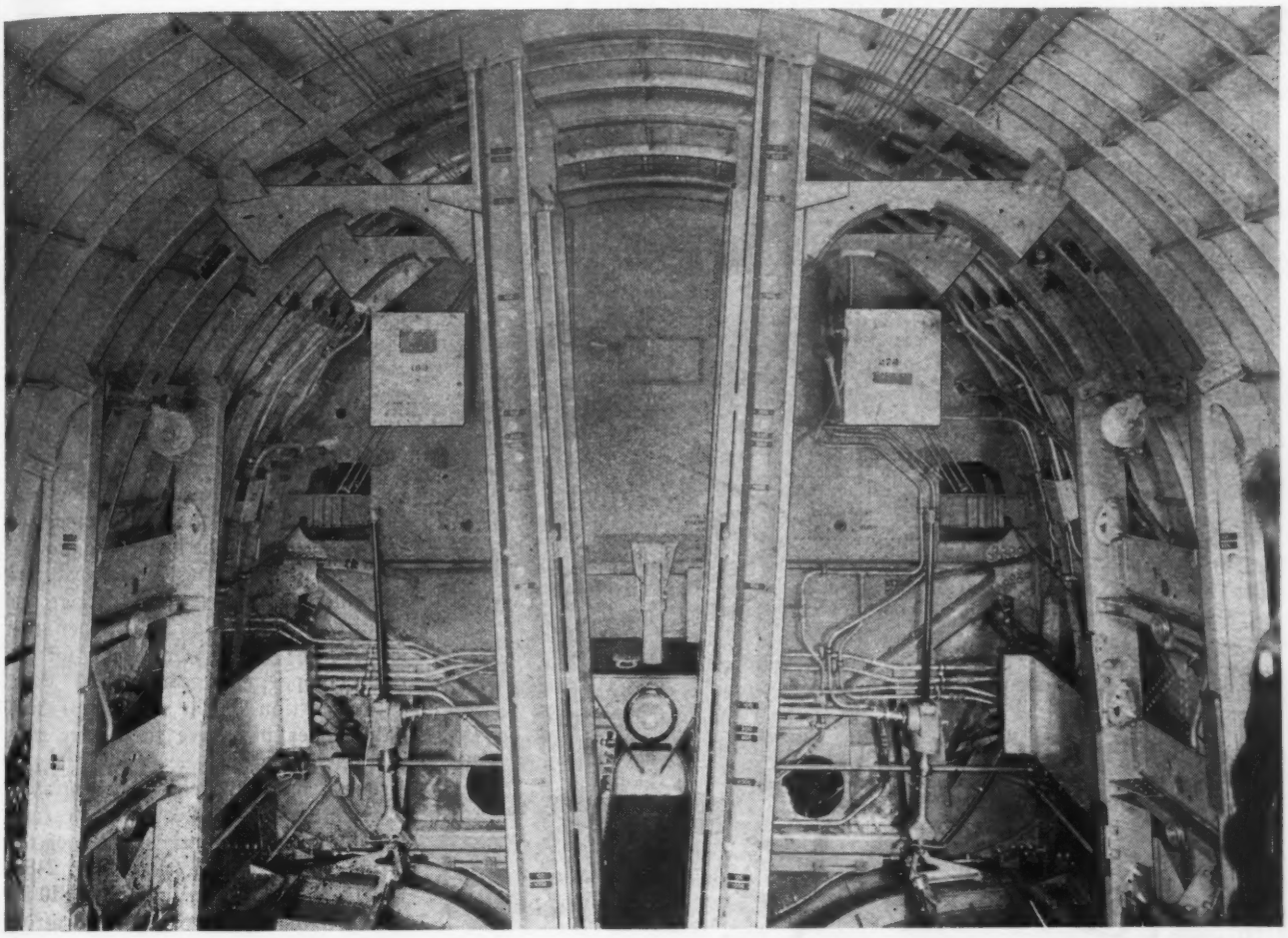
Rear view of bulkhead No. 10, located aft of tail wheel, under vertical fin rear spar. Terminals for spar attachment are at top.



Exploded view of Boeing B-17 Flying Fortress showing sub-assembly breakdown.







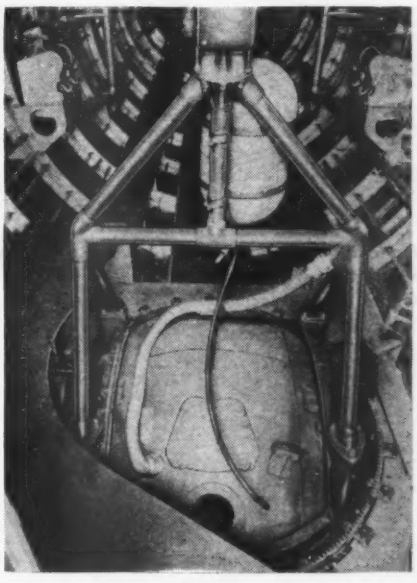
Interior of bomb bay, looking forward. Left and right of catwalk light at rear are gear boxes and actuating screws for bomb bay doors. In center are inboard bomb racks fitted with tank cradle upper supports. Outboard racks are seen at fuselage sides.

Basically, the Fortress' fuselage has remained unchanged, although like the vertical fin assembly, it has undergone considerable modification and modernization. To provide for the added tail stinger, it was necessary to increase the diameter of the rear half of the fuselage. But while this obviously required dimensional increases in the structures, it did not require revision of the basic, original design formula.

The circular fuselage cross-section was adopted because it is more efficient from a standpoint of strength-weight ratio and ease of manufacture. In the latter respect, ability to form skin and stiffeners in continuous forming dies was a manufacturing factor which influenced design.

The fuselage is an all-metal, semi-monocoque structure with a maximum cross-section height of 103 in. and maximum width of 90 in. Its structural design, like that of the wing, is such that strength is well distributed, and while built around rail-section longerons in the forward half, damage to one or more of them does not necessarily cause failure to the entire structure.

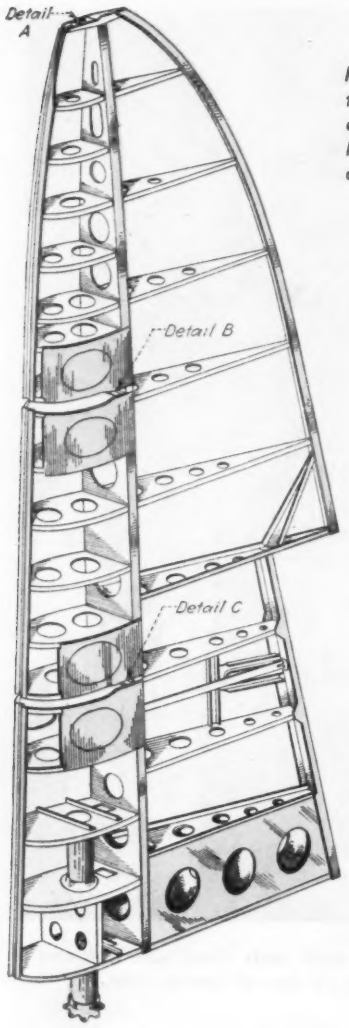
The front section, which includes the bomb bay, has three rail-section longerons of extruded 24ST, two in the top and one at the bottom to carry the load and reinforce the pilot's compartment which is a cutout in the top of the basic monocoque structure. All three rail-sections taper from the wing joining area, toward the front, reducing from I to T sections.



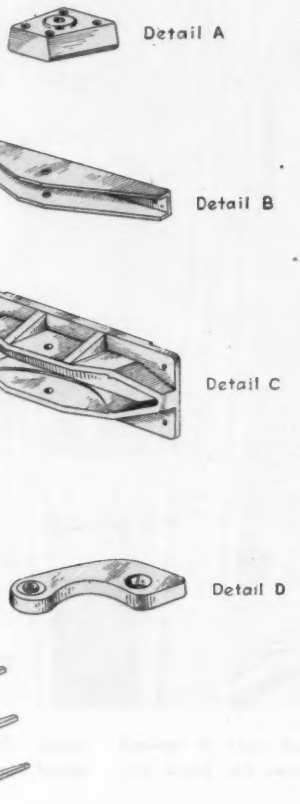
Interior view showing mounting of bottom gun turret. Azimuth gear is seen at lower right. Also visible are gunner's oxygen bottle and line, and turret power conduit.

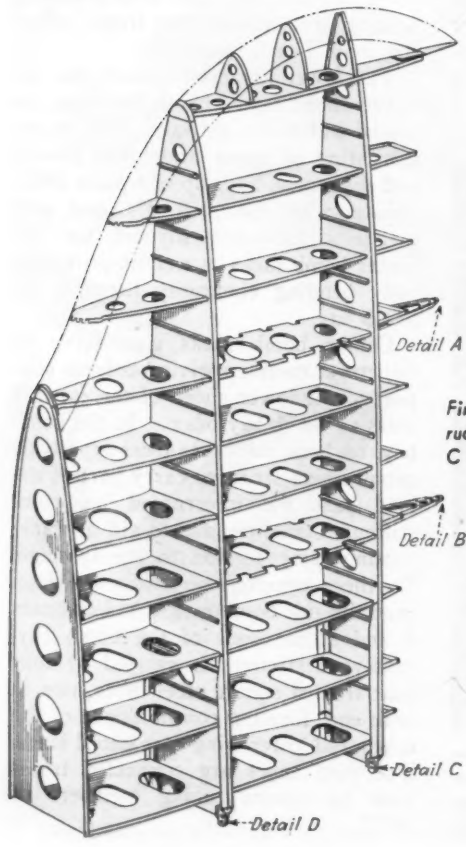
The lower longeron splices into the lower chord of the bomb bay beam on top of which is a catwalk. This truss, consisting of upper and lower chords and diagonals, built up of square 24ST tubing with extruded T's and web members furnishes support for the center bomb racks as well as providing body bending continuity through the bomb bay.

Center bomb racks also serve as structural members giving column support to the lower chord of the catwalk truss or bomb bay beam. In the bomb bay, on both sides, are truss type body compression struts to carry part of the load past the interrupted longeron-stiffener structure, and to aid in transmitting wing torsion to the fuselage. To these compression struts are fastened the side bomb racks. At bulkheads 4 and 5, the ends of the bomb bay, crosswise strength is carried by four heat treated square steel tubes, two in each end, forming continuations of the upper and lower wing spar chord loads. The steel tubes are connected trusswise by square tubing members of 24ST.



Rudder assembly construction features, with top hinge shown at detail A, center hinge at B, lower hinge at C, and tab actuating hinge at D. Rudder torque tube at bottom attaches to control quadrant.





Fin assembly construction features, showing rudder hinges at A and B, and terminals at C and D for attachment to bulkheads.

Vertical Tail Surfaces

FIN	
Area (including 42.4 sq. ft. in dorsal)	142.9 sq. ft.
Normal setting	0 deg.
Angular movement	None
RUDDER	
Area (including tab and balance)	38.8 sq. ft.
Angular movement (with stops compressed. Right & Left)	22 ± 2 deg.
(available, using cockpit control)	21 ± 2 deg.
Type of balance	Mass
Aerodynamic chord balance	26 ± 2%
Tab area	3.4 sq. ft.
Tab angular movement (both ways from center)	22 ± 2 deg.

Fuselage load is carried in the portion just aft of the bomb bay by four rail-section longerons which taper out aft of station 6. The lower two provide additional reinforcing for the ball turret cutout and give the fuselage the required strength. The upper two longerons provide reinforcing for the radio compartment gun hatch.

Aft portion of the fuselage (about half), does not have the heavy rail-section longerons, depending for its strength upon a greater concentration of lighter extruded bulb angles and heavier circumferentials. All of the latter, Z-type, are formed from 24ST sheet and vary in spacing from 10 in. forward of station 6 to 20 in. aft of station 6, being heavier where spacing is wider.

For distributing concentrated loads from wing, tail gear, and empennage to the fuselage, bulkheads of varying design are used. They vary from solid—except for passage door—to bulkheads with slightly more than unusually wide circumferentials. All are built up from flat sheet, rolled and stamped sections, and extrusions, riveted together. In addition to imparting strength, they provide convenient supports for control linkage and equipment.

The truss around the bomb bay serves as the anchor point of the wing terminals, which are connected to the crosswise trusses in the fore and aft ends of the bay, projecting outside the fuselage. A similar carry-through arrangement at bulkheads 8, 9, and 10 in the aft section, supports the empennage assembly. The carry-through members are 24ST tubes and hydropressed sheet webs. The tail wheel structure is supported by bulkhead 7 which has two vertical members.

Front fin spar terminals are attached to bulkhead 9, and rear fin spar terminals attach to bulkhead 10. Stabilizer terminals are just outside the fuselage at stations 8 and 9 to which they attach.

Tail gunner's compartment, built as a separate component, relies primarily on skin and circumferential stiffeners

for its strength, having no longitudinal stiffeners.

Framework of the plane consists of bulkheads and circumferential stiffeners, tied together throughout the length of the fuselage by longerons and longitudinal stiffeners aft to station 11; front and rear spars in the wing; crossties of nose, center, and tail ribs; and ribs and formers in the tail surfaces. A skin of 24ST Alclad is laid over this framework and fastened with aluminum alloy rivets. The thickness of the skin varies with the locality and depends upon the amount of load carried.

On the wing, for instance, the skin—carrying two-thirds of the wing loads—is reinforced by corrugated dural which prevents buckling of skin between ribs. Additional reinforcement is also given to skin surrounding wheel well, exit, and access doors, and other cutouts in the structure.

Supports for the pilot's cockpit are large built-up beams under the floor, sloping aft to connect with the pilot's cabin floor structure supporting the top turret immediately behind the pilot and co-pilot's seats and anchoring to bulkhead 4 below the cockpit.

Four means of emergency entrance and exit—in addition to pilot's and co-pilot's windows and the radio compartment hatch—are: releasable hinged door in forward portion of fuselage; bomb bay doors; releasable hinged door near tail gunner's station, on right hand side; and releasable hinged door forward of bulkhead 7 on the right hand side. All except the bomb bay doors are operative from either inside or outside.

Pilot's compartment, reached through a doorway in the bulkhead between it and the bomb bay, is equipped to seat the commander-pilot on the left and co-pilot on the right. Seats are adjustable vertically and fore and aft, and accommodate seat or back-type parachutes. Front window panels are fixed and leakproof; sliding type side panels are of shatter-proof, dehydrated glass, $\frac{1}{4}$-in. thick, and fixed side panels are $\frac{3}{16}$-in. transparent plastic.

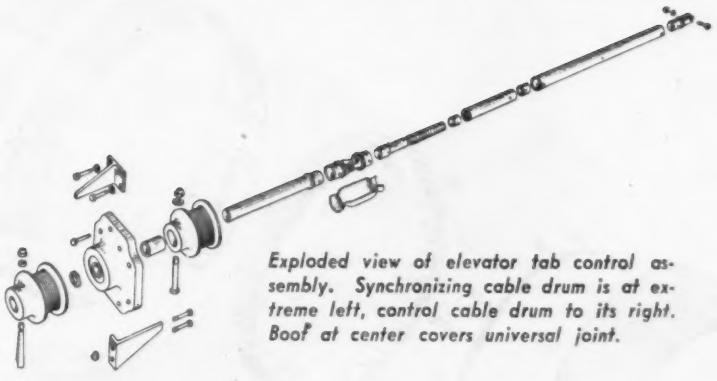
Engine nacelles are typical monocoque structures with four 24ST extruded longerons and several formed longitudinals located between the evenly spaced longerons. Longitudinal members are tied together with rolled sheet Z-section circumferentials, spaced about 10-in. apart. Skin is 24ST except around exhaust stacks, where stainless steel is used. The firewall is also stainless steel.

Engine mounts are standard ring type of normalized X4130 steel tubing, arc-welded with X4130 steel forgings at the four firewall connections. Each mount is interchangeable.

Spacing between fuselage fairing and wings is approximately 10-in. to provide for the wing joint, and is covered by hydropressed 24ST Alclad sheet fairing, held in place by means of machine screws and nut plates. The horizontal stabilizer, spaced with a 15-in. gap between it and the fuselage, is also covered with fairing.

The Fortress was one of the first planes to "put the breeze to work" to take loads off of controls through the use of tabs, and one of the first to actuate retractable gear and other parts by means of electric motors as well as by manual drive shafts. This electrical installation has proven to be an outstanding member of that group of original innovations for which the plane has become famous. Combat damage, it was reasoned, would be less likely to put entire units out of commission if they were electrically controlled by means of dispersed and practically duplicate wiring systems. Thousands of instances of partial combat damage which failed to prevent operation have confirmed the soundness of that reasoning. Landing gear, flaps, and bomb bay doors are all electrically operated.

Manual control systems, likewise, are rather unique in that those to all control surfaces connect to and operate over quadrants, which makes them free-moving and easy to handle. Routing of cables is direct, with a minimum of pulleys and sharp angles in cable courses.

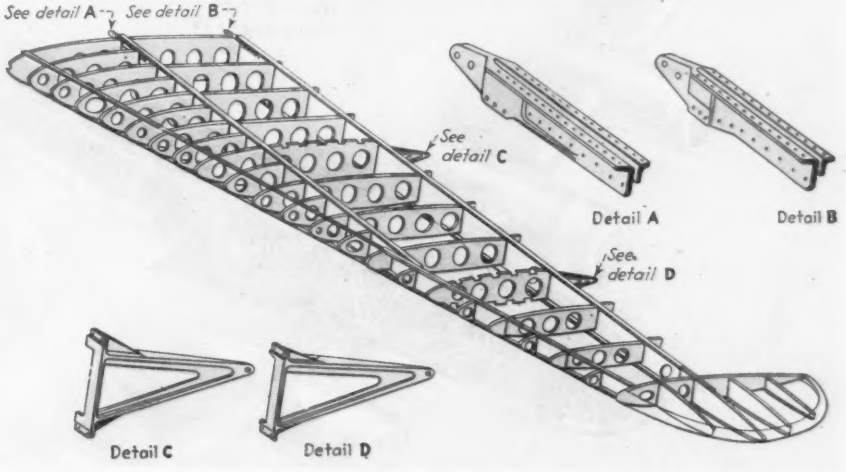


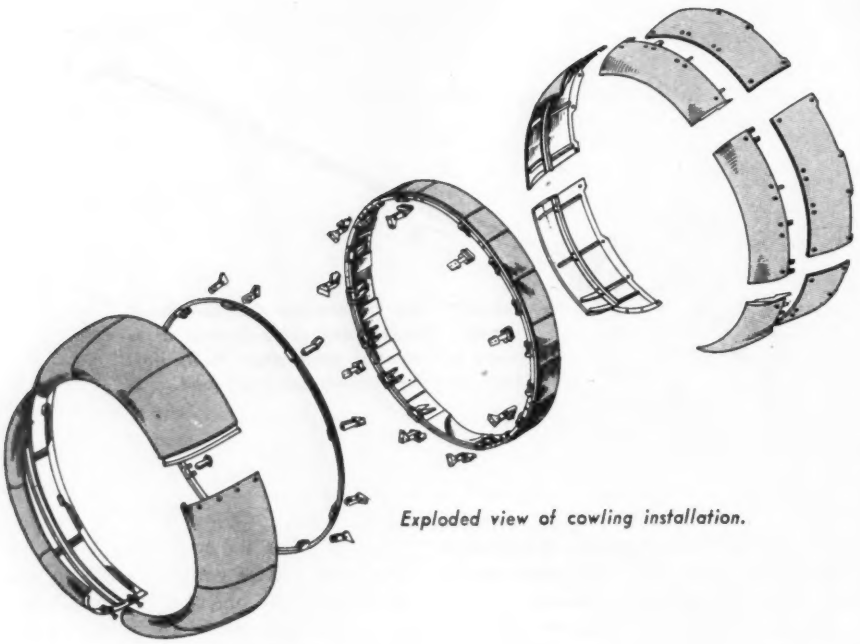
Exploded view of elevator tab control assembly. Synchronizing cable drum is at extreme left, control cable drum to its right. Boof at center covers universal joint.

Horizontal Tail Surfaces

Area	331.1 sq. ft
Span	43'
Maximum chord	125"
Distance from normal C. G. to 1/3 max. chord point	451.0"
STABILIZER	
Area	250.6 sq. ft.
Normal setting, relative to longitudinal axis	0 deg.
Angular movement	None
ELEVATOR	
Area (including tabs and balance)	115.0 sq. ft.
Angular movement (up)	23 ± 1 deg.
(down)	14 ± 1 deg.
Chord aerodynamic balance	27 ± 3%
Type of balance: uniformly distributed mass, 100% statically balanced about hinge centerline.	
Tab area	5.0 sq. ft.
Tab chord	11.10"
Tab span	60.26"
Tab angular movement (up or down)	11 ± 2 deg.

Stabilizer assembly. Note that front spar does not extend to tip end. Leading edge and rear spar take over as shear-carrying structure from end of front spar to tip (8 ft.). Stabilizer terminals at fuselage are shown at details A and B and elevator hinges at C and D.





Exploded view of cowling installation.

Landing gear is standard three-point type. Main gear is oleo-pneumatic, of Boeing design, with tread width of 21 ft. 1½-in. The oleo strut is 9 19/32-in. in diameter. Wheel diameter is 56-in., requiring a 16-ply tire, 56:19–23.

Main gear moves up and forward when retracting, leaving a small portion of the tire exposed when the gear is fully retracted. Tail wheel retracts fully. Brakes are dual hydraulic, obtaining pressure from an accumulator supplied in turn by an electrically driven pump and emergency hand-pump.

Retracting mechanism for each leg consists of a retracting screw actuated by an electric motor attached to the screw by gearing, and a manual drive shaft. Retracting screws and nuts are interchangeable as units. Manual retracting shafts terminate on the rear side of the front wall of the bomb bay and are operative by the engine starter crank. Right and left main gear legs retract simultaneously when motor-driven, but individually when cranked.

Brakes are operative through pilot's or co-pilot's pedals, but the parking brake control is operative only by co-pilot and consists of a manually operated eccentric device which will hold the valves open. Tail wheel mechanism is similar to that of main gear and is similarly controlled.

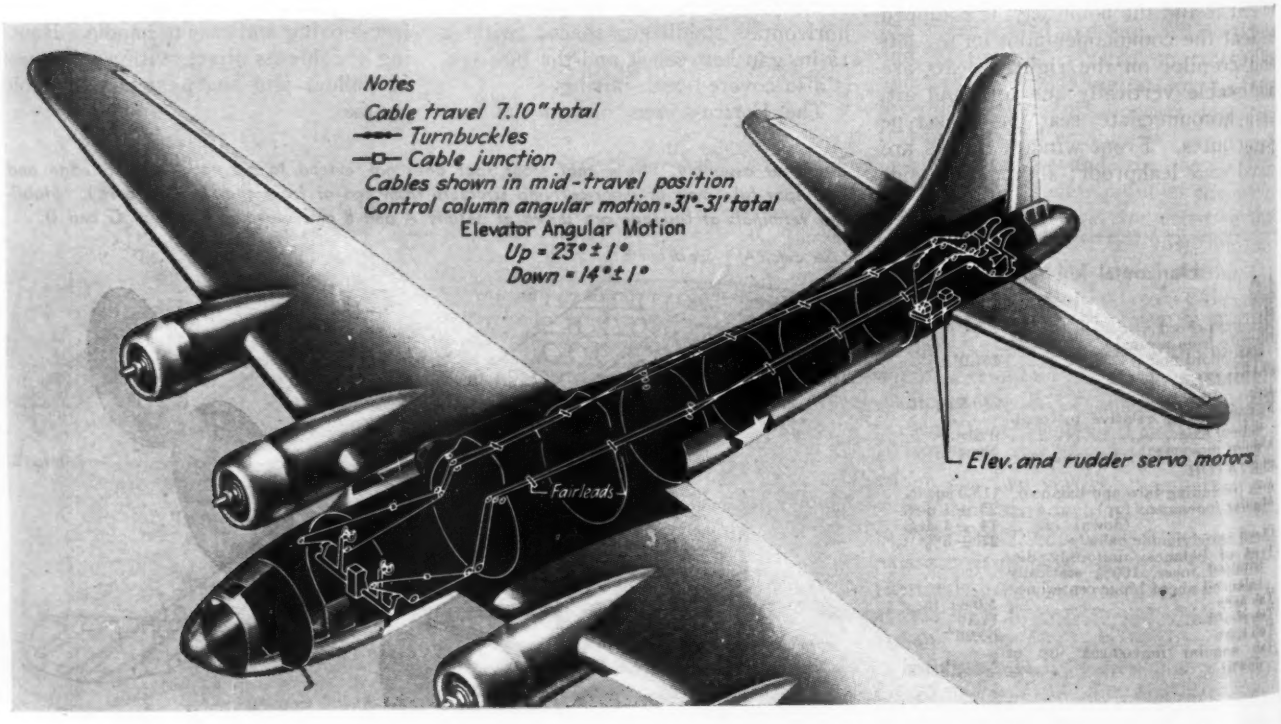
Main wheel motion resulting from shock absorber deflection is along a line approximately 20 deg. aft in the level landing position. Friction in the gearing and screw mechanism is sufficient for locking and for absorbing kinetic energy of the moving mechanism after power supply is cut off.

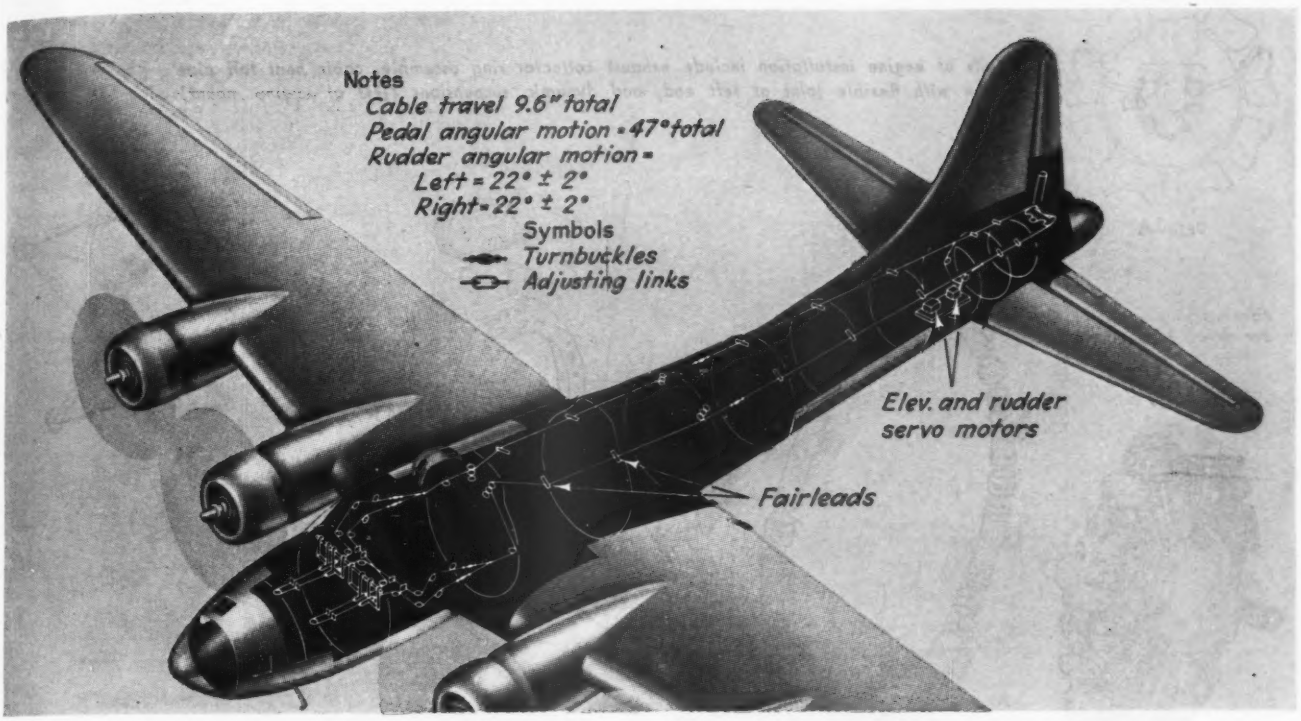
Engines are 9-cylinder Wright Cyclone, model R-1820, with 16:9 ratio from crankshaft to propeller shaft, and are rated at 1,200 hp each. They are equipped with Bendix Stromberg PD-12H2 injection carburetors and General Electric type B-22 turbo-superchargers.

The supercharger is installed in the engine exhaust system at the bottom of the nacelle. On the outboard nacelles the location is forward of the front spar, but on the inboard nacelles the location of the wheel well necessitates installation of the turbo (and intercooler) aft of the front spar.

The induction system is so designed that carburetor air must pass through the supercharger impeller and intercooler at all times. Exhaust gas pressure drives the impeller by flowing through a nozzle box where the gas is directed against a turbine wheel mounted on the lower end of the impeller shaft. Flow of exhaust gas through the turbine wheel is controlled by the waste gate in the nozzle box; thus, all or a part of the exhaust gas may be untilized to obtain the desired manifold pressure. The exhaust tail

Phantom view of elevator control system.





Phantom view of rudder control system. Quadrant at extreme right is attached to torque tube.

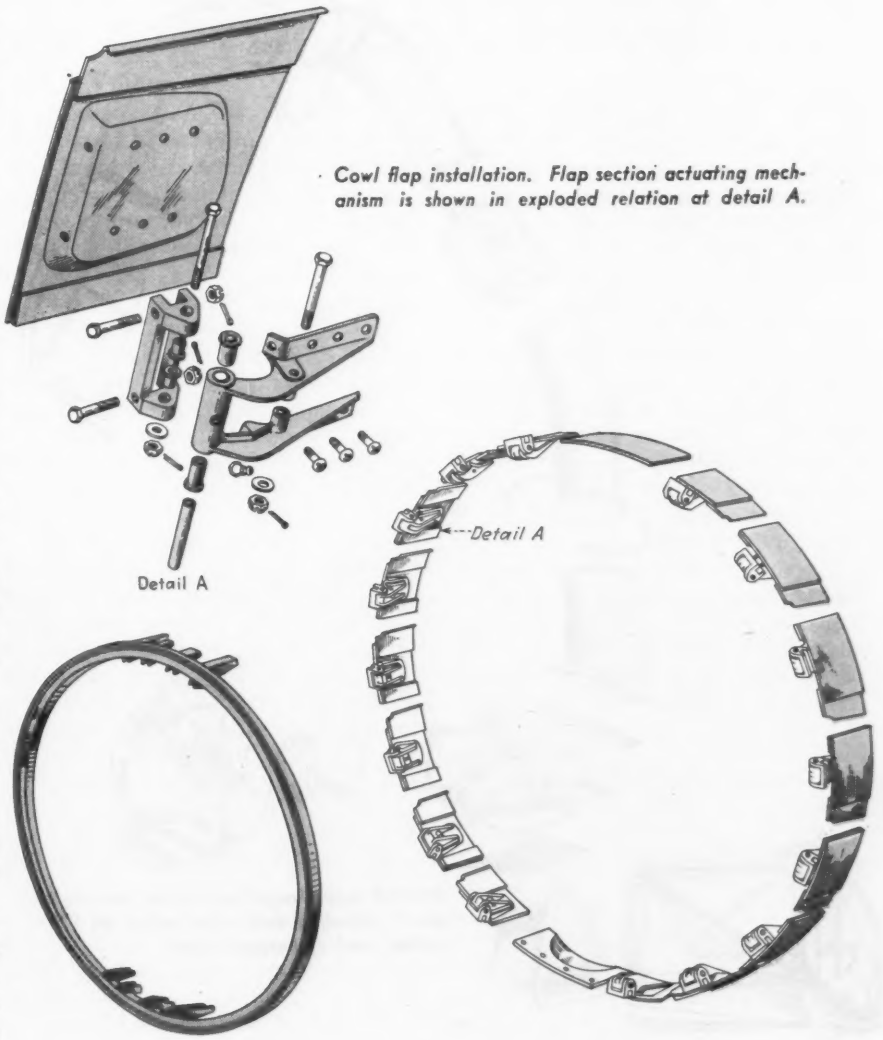
pipe arrangement ends at the turbo.

Carburetor air flows into the duct system at the wing leading edge, and passes to the supercharger impeller, by which it is compressed and forced through the intercooler into the carburetor. A relief valve is provided in the supercharger intake duct to permit the entrance of air to the supercharger if the flow through the inlet is accidentally restricted.

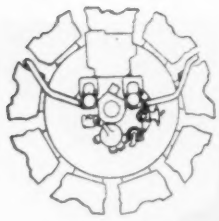
The inboard intercooler is located in the wing, directly aft of the nacelle, and the outboard intercooler is situated vertically in the nacelle, immediately behind the firewall. The purpose of the intercooler is to reduce the carburetor air heat resulting from compression by the superchanger. This reduction in temperature is accomplished by the passage of cold air around the intercooler from a second intake duct. The cooling air is then spilled overboard thru slots in the wing surface. The intercooler is similar to a coolant radiator or oil cooler.

One of the significant improvements on the Fortress is the addition of the Minneapolis-Honeywell electronic turbosupercharger control on the B-17G. This device, replacing the former engine oil regulator with its cable and push rod controls, has three distinct advantages:

First, it provides a system of manifold pressure control easily operated by the pilots and is sufficiently sensitive to maintain close regulation. One adjusting knob simultaneously controls

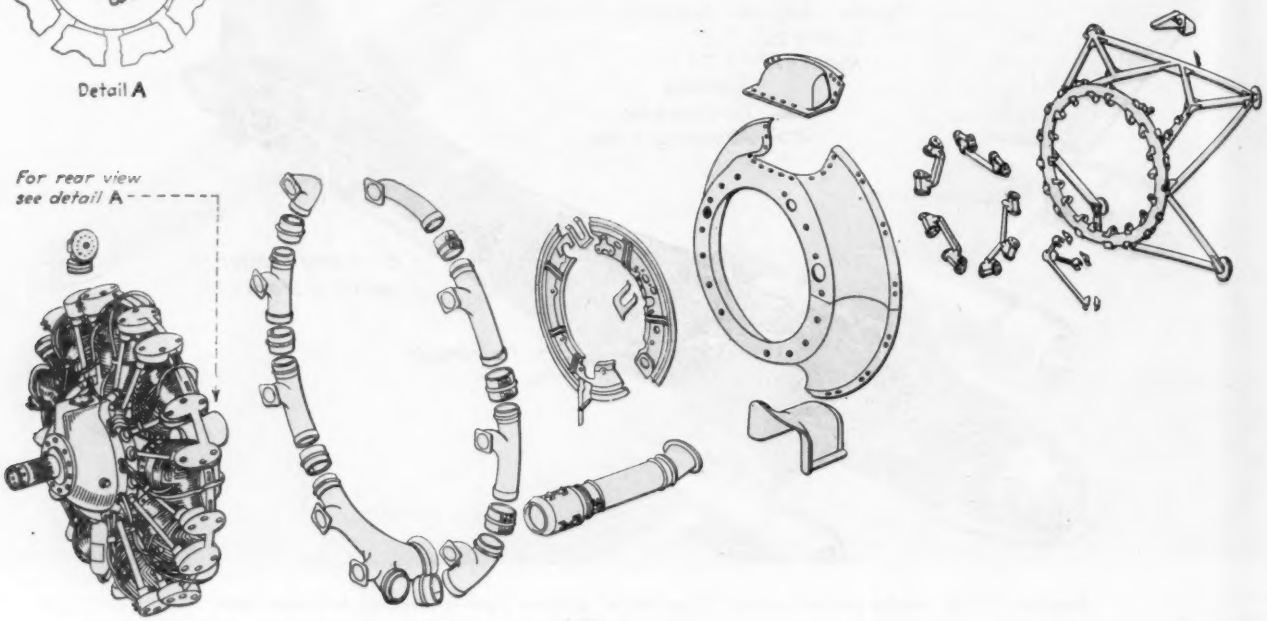


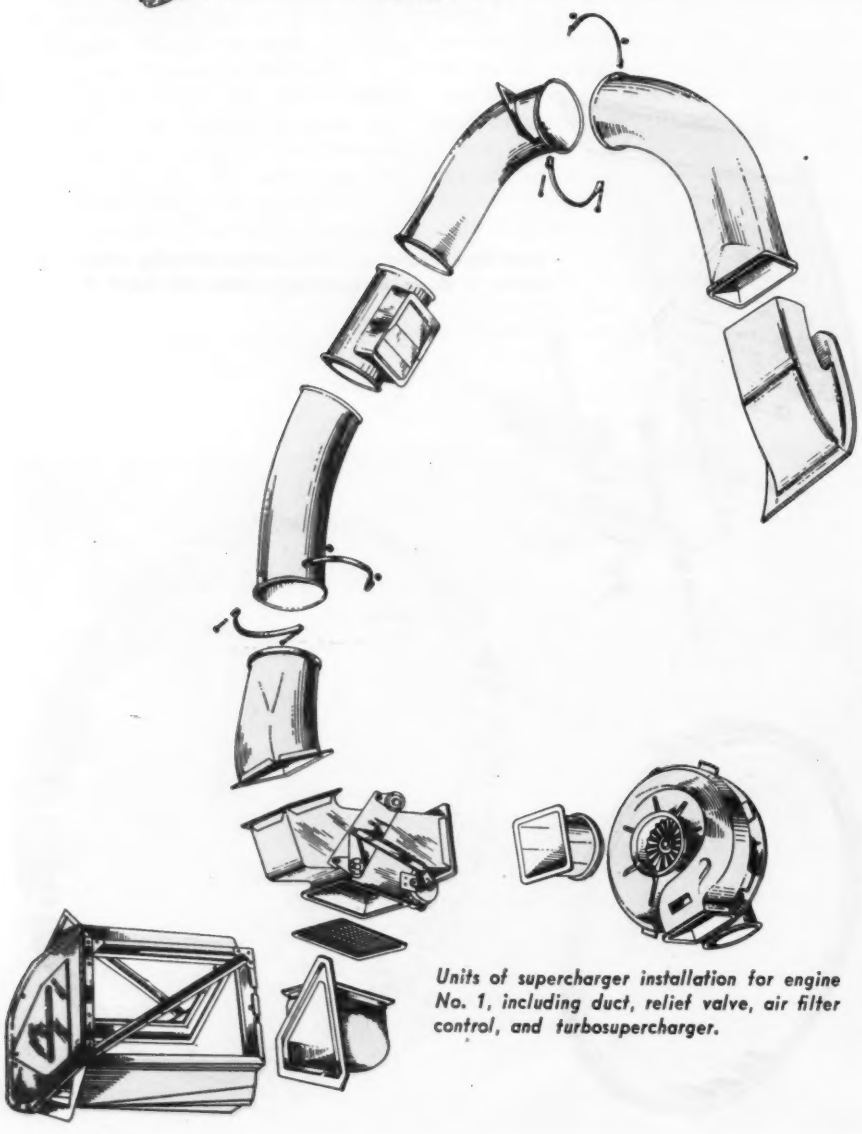
Cowl flap installation. Flap section actuating mechanism is shown in exploded relation at detail A.



Detail A

Details of engine installation include exhaust collector ring assembly, cabin heat tail pipe section with flexible joint at left end, and dynamic suspensions (left of engine mount).





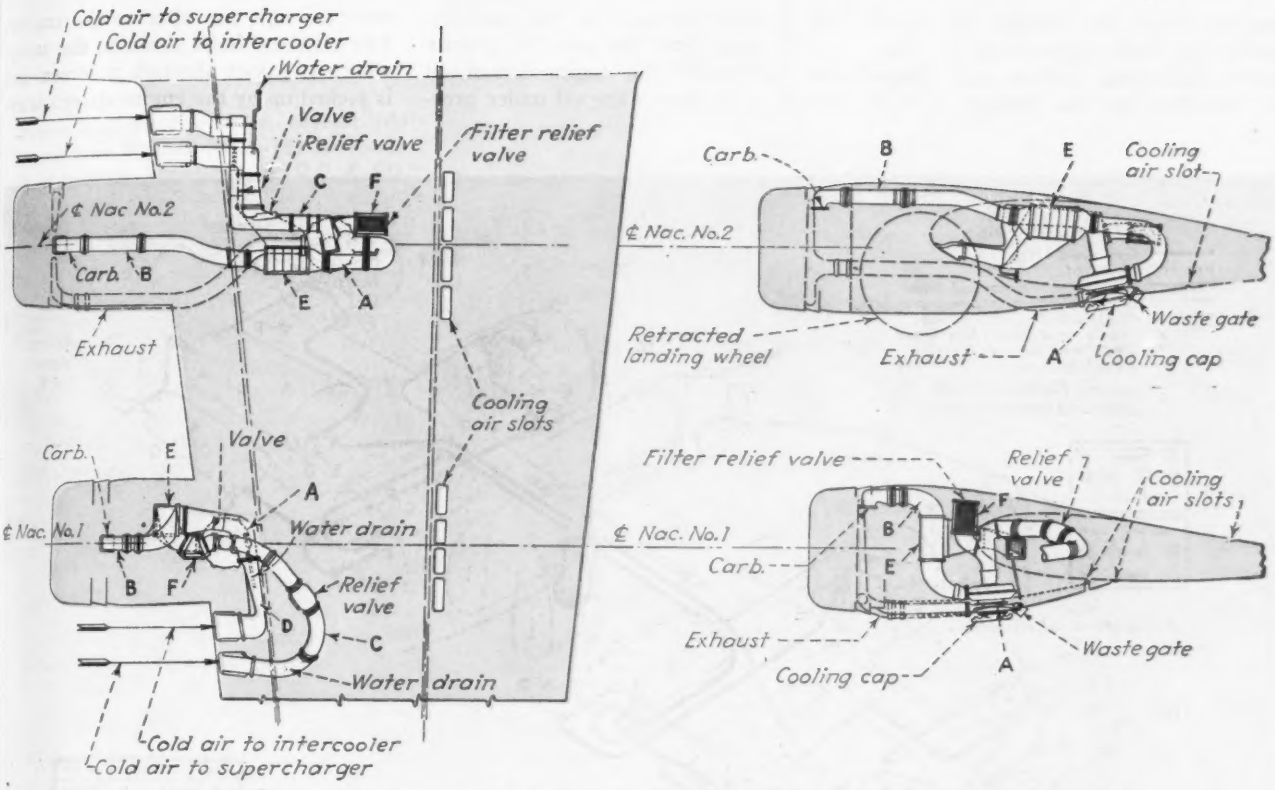
Units of supercharger installation for engine No. 1, including duct, relief valve, air filter control, and turbosupercharger.

Unit Weights

Wing group (1,277.5 sq. ft.)	4.64 lb. per sq. ft.
Tail group (440.4 sq. ft.)	2.18 lb. per sq. ft.
Weight of lubricating system per gal. of oil (148 gal.)	5.42 lb.
Weight of fuel system per gal. of fuel (2,780 gal; does not include bomb-bay tanks)	1.23 lb.

Design Weights

WING GROUP		
Center section or inner panels		4,609 lb.
Outer panels		942 lb.
Wing tips		92 lb.
Ailerons (counterbalance weights 24 lb.)	total	129 lb.
Flaps		169 lb.
TAIL GROUP		
Stabilizer		445 lb.
Elevators (counterbalance weights 14.5 lbs)	total	177 lb.
Fin		257 lb.
Rudder (counterbalance weights 17.3 lb.)	total	78 lb.
BODY GROUP		
Fuselage		3,498 lb
Fuselage turrets (included in armament provision)		
LANDING GEAR		
Main gear		2,634 lb
Tail gear		257 lb.
POWER PLANTS		
Engines (4)	total	5,252 lb.
Accessories		1,675 lb.
Power plant controls		109 lb.
Propellers and spinners		1,902 lb.
Starting system		195 lb.
Nacelles and cowling		
Inner		1,270 lb.
Outer		982 lb.
Lubricating system	total	802 lb.
Tanks and protection		465 lb.
Piping, ducts shutters, supports		337 lb.
Fuel system	total	3,415 lb.
Tanks and protection		2,656 lb.
Piping, fittings, supports, etc.		759 lb.
FIXED EQUIPMENT		
Instruments		337 lb.
Surface controls (including automatic flight control equip.)		576 lb.
Electrical		1,058 lb.
Communication		586 lb.
Armament (includes armor plate, glass, turrets)		2,766 lb.
Anti-icing		294 lb.
Furnishings	total	1,022 lb.
Air-conditioning		163 lb.
Provisions for flight		469 lb.
Emergency		104 lb.
Personnel accommodations		286 lb.



Diagrammatic representation of supercharger installation. Left: plan view of L.H. wing and nacelles (R.H. similar); upper right: L.H. view, No. 2 nacelle; and lower right: L.H. view, No. 1 nacelle. (A) is supercharger, (B) pressure duct, (C) air duct, (D) intercooler duct, (E) intercooler, and (F) air filter frame.

all four engines. A governor prevents turbo overspeeding. Manifold pressure is readily held during takeoff, climb, cruise, or glide.

A second important advantage is that cold weather problems in the operation of the former hydraulic system with the balance line are eliminated. Condensation in this line presented serious cold weather difficulties. Adoption of the electronic system was made partly on the basis of winterization considerations.

The final advantage is the saving of 30 lb. over the old installation.

The complete installation consists of a single control knob and selector panel, pressure controls, turbo overspeed governors, amplifier units, and waste gate control motors. When the control is in operation the pilot sets the selector to a desired position and this in turn sets the pressure control. The governor controls the rate at which the change in turbo speed takes place and prevents overspeeding of the wheel. The amplifier provides current to the motor for closing or opening the waste gate as required.

Propellers are Hamilton Standard Hydromatic, controllable, full feathering, 11 ft. 7 in. diameter. Minimum clearances are: to ground, level landing, inboard, 17 9/32 in., outboard, 30⅛ in.; to fuselage, inboard, 9⅜ in.; to engine cowl, full feathered, ½ in.; to leading edge of wing, 70 in.; and inboard to outboard, 25 7/17 in. Each propeller has its own feathering motor pump unit and draws oil for the pump from a standby reserve in the engine oil tank.

The engine cowling is made in three portions; the anti-drag or ring cowl, the cowl flaps, and the orange peel or inner cowl which is also called the accessory section cowl.

The engine ring cowling is hydropressed 24ST sheet, reinforced with spotwelded doublers, ribs, and extrusions along the edge of each of the three segments. The accessory section cowl is in five pieces and is made of stainless steel.

The fuel storage system includes 24 leakproof tanks. The largest hold 425 gal., and one is installed in each inner wing panel between the nacelles and to the rear of the front spar. A 212 gal. tank is installed in each inner wing between the 425 gal. tank and the rear spar. A 213 gal. tank is located on each side between spars, inboard of the inboard nacelle. Nine smaller feeder tanks (known as Tokyo Tanks) are located in each wing outboard of the outboard nacelles, four in the inner wing and five in the outer wing panel.

A droppable leakproof tank of 410 gal. can be carried on each side of the bomb bay in place of corresponding bombs.

Fuel distribution is through four systems, each supplying one engine. By means of a reversible electrically driven fuel transfer pump, selector valves and interconnecting lines, fuel can be transferred from any auxilliary or engine tank to any other engine tank. Fuel booster pumps are installed in the outlets of four engine tanks to combat vapor lock at high altitudes and to supply extra fuel for takeoff.

An electrically controlled fuel shutoff valve is installed in the line between each fuel boost pump and the engine to prevent flow to a severed line in a nacelle or engine section. From the shutoff valve, fuel passes through a strainer mounted on the forward side of the firewall and enters the engine-driven fuel pump. From there it passes through the carburetor.

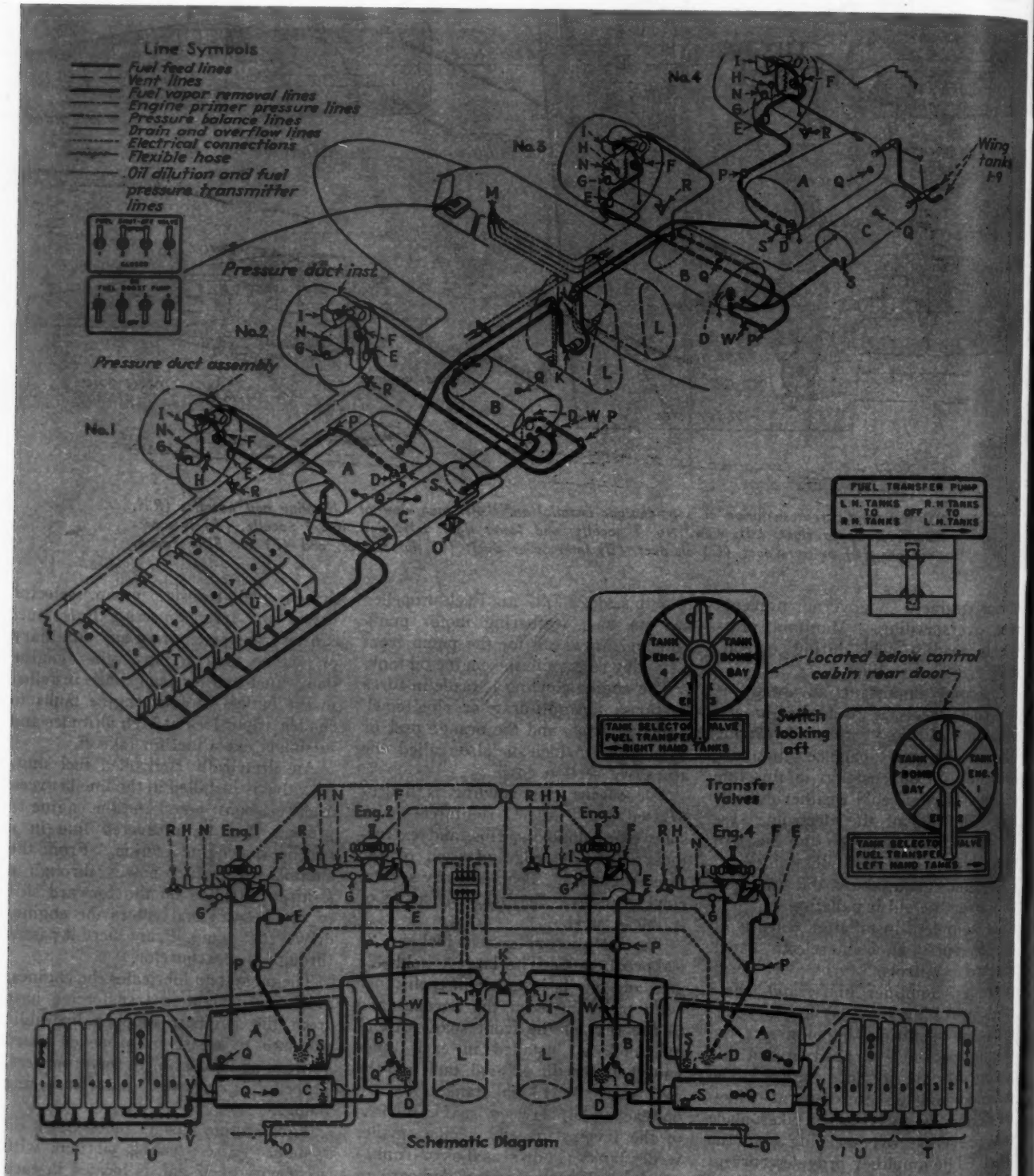
The oil system lubricates the engines, aids as a coolant in transferring heat from the engines, supplies hydraulic pressure to assist in propeller speed control, and feeds oil to the propellers, propeller governors and feathering pumps.

Each engine has its independent oil system. A self-sealing oil tank with a capacity of 37 gal. is located in each nacelle aft of the firewall, and is designed for a maximum diving angle of 25 deg.

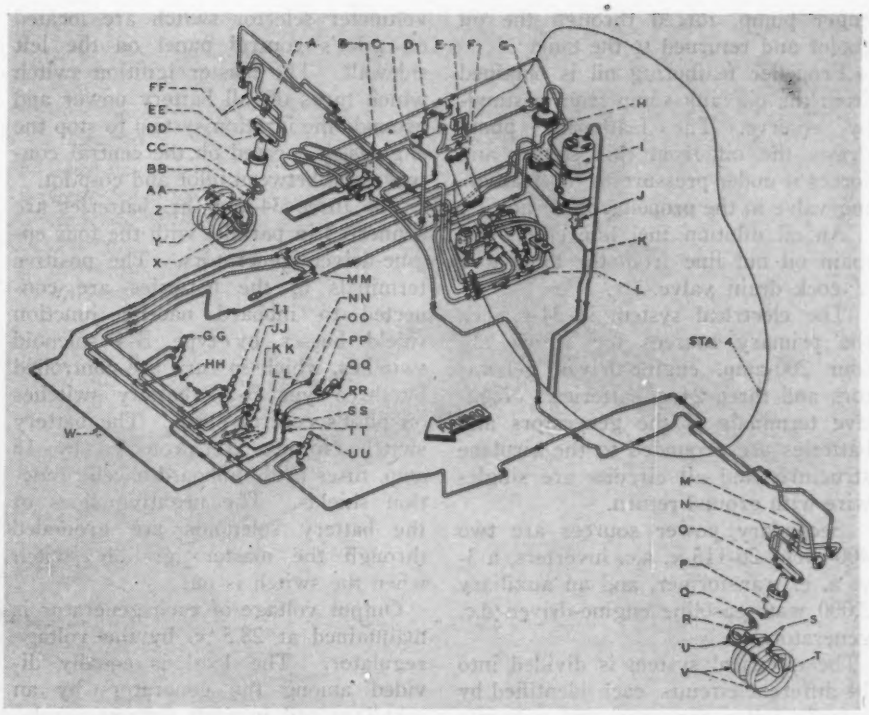
Oil cooler and temperature regulators are installed in the leading edge of the wings. The oil pump, Cuno filter, and scavenger pump are incorporated in the engine. Individual oil tanks of 1½ gal. capacity and with ½ gal. ex-

pansion space are provided for lubrication of each supercharger. Propeller feathering motors and pumps are mounted on the forward side of the firewall of each of the nacelles.

Oil flows from the tank by gravity and suction to the engine-driven oil pump which forces the oil under pressure through the filter to the engine. The oil then drops down to the sump, where it passes through a screen and is picked up by the engine-driven scav-

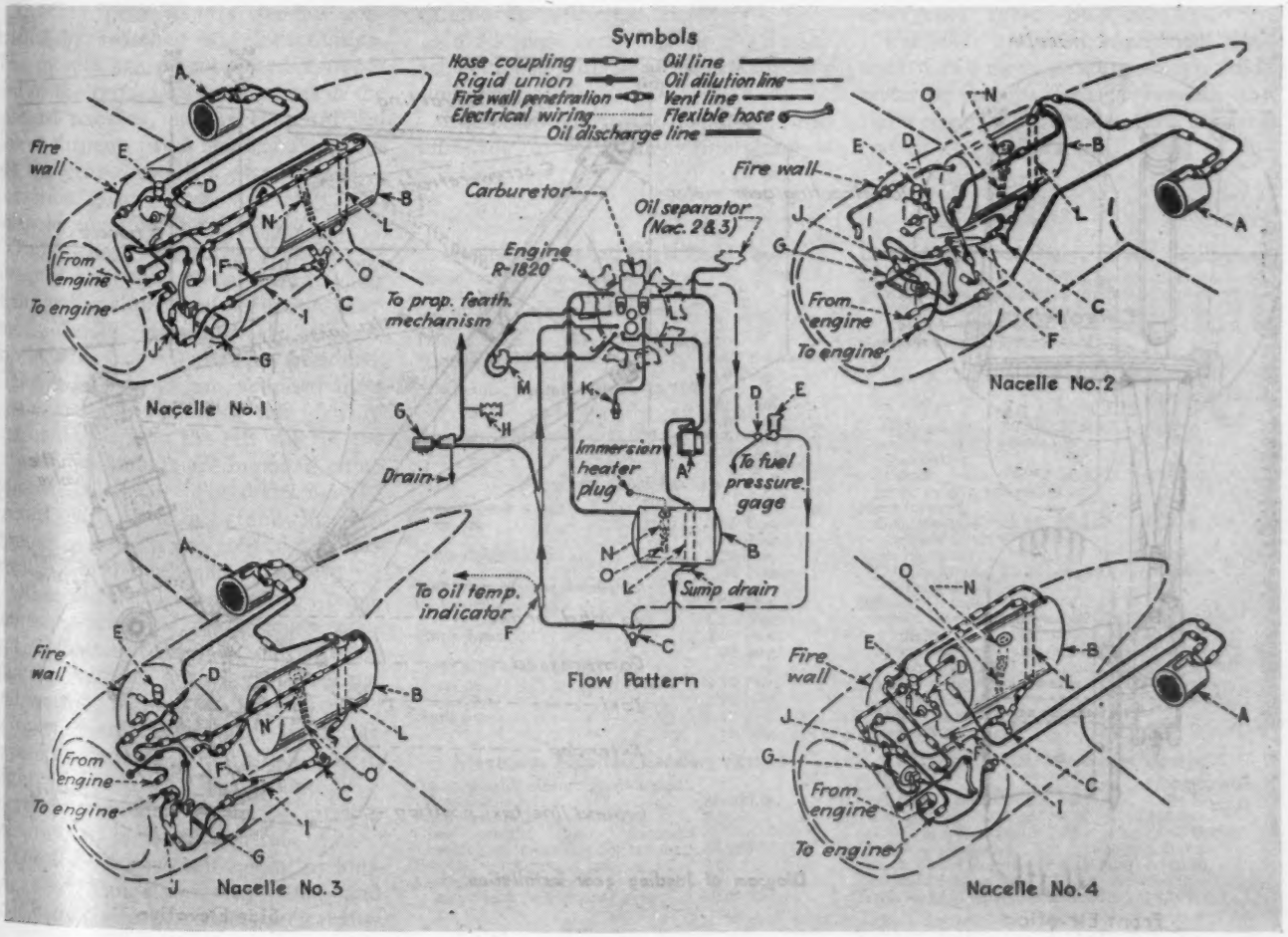


Diagrammatic representation of fuel system. Legend: (A) No. 1 & 4 engine tank; (B) No. 2 & 3 engine tank; (C) feeder tank; (D) booster pump; (E) fuel strainer, inboard; (F) engine fuel pump, type 6-9; (G) fuel pressure transmitter, type C 14A; (H) oil dilution valve; (I) carburetor; (J) fuel transfer selector valve; (K) transfer pump; (L) bomb bay fuel tank; (M) primer, 4 engine fuel; (N) twin restriction fitting; (O) tank vents—underside of wing; (P) fuel shut-off valve; (Q) tank filler neck; (R) oil drain cock assembly; (S) drain cock; (T) outboard wing tanks No. 1—5; (U) inboard wing tanks No. 6—9; (V) valve-swing check; and (W) tank drain valve.



Hydraulic system installation. Legend: (A) copper tube ½" O.D. X .35; (B) emergency brake metering valves; (C) ⅜" O.D. X .035, 52SO; (D) relief valve; (E) selective check valve; (F) emergency accumulator; (G) manual shutoff valve; (H) accumulator; (I) supply tank; (J) drain cock; (K) ⅜" O.D. X .035, 52SO; (L) hydraulic panel; (M) hose assembly, ½" tube; (N) copper tube ½" O.D. X .035; (O) shuttle valve; (P) return boost valve; (Q) copper tube ½" O.D. X .035; (R) hose assembly ½" tube; (S) inlet connection; (T) hose assembly ½" tube; (U) copper tube ½" O.D. X .035; (V) dual duplex brake expander tubes; (W) ⅜" O.D. X .035 52SO; (X) copper tube ½" O.D. X .035; (Y) hose assembly, ½" tube; (Z) inlet connection; (AA) dual duplex brake expander tubes; (BB) hose assembly ½" tube; (CC) copper tube ½" O.D. X .035; (DD) return boost valve; (EE) shuttle valve; (FF) hose assembly ½" tube; (GG) brake metering valve; (HH) to cowl flap valve; (II) brake metering valve; (JJ) to cowl flap valve; (KK) brake metering valve; (LL) ⅜" O.D. X .035 52SO; (MM) hand pump; (NN) hose assembly ¼" I.D. tube; (OO) main hydraulic pressure valve; (PP) emergency hydraulic pressure valve; (QQ) emergency pressure warning switch; (RR) ¼" O.D. X .035 52SO; (SS) ¼" O.D. X .032 or .035 SO; (TT) restriction fitting; and (UU) brake metering valve.

Diagrammatic representation of oil system. Legend: (A) oil temperature regulator; (B) oil tank; (C) drain valve; (D) restriction fitting; (E) oil dilution valve; (F) oil temperature bulb (electric resistance); (G) propeller feathering pump; (H) pressure cutout switch (Type 4G8-G6C); (I) tube assembly (welded); (J) tube assembly (welded); (K) oil pressure trans. (type B-9A); (L) oil temperature accelerating well; (M) supercharger regulator; (N) heater receptacle assembly; and (O) immersion oil heater.



enger pump, forced through the oil cooler and returned to the tank.

Propeller feathering oil is obtained from the oil tank sump from a standby reserve. The feathering pump draws the oil from this source and forces it under pressure to the feathering valve in the propeller governor.

An oil dilution fuel line enters the main oil out line from the tank at a Y cock drain valve.

The electrical system is 24-v. d.c., the primary sources for which are four 200-amp. engine-driven generators and three 24-v. batteries. Negative terminals of the generators and batteries are grounded to the airplane structure, and all circuits are single-wire with ground return.

Secondary power sources are two 400-cycle, 26-115 v. a.c. inverters, a 3-v. a. c. transformer, and an auxiliary 2,000 watt gasoline engine-driven d.c. generator.

The electrical system is divided into 14 different circuits, each identified by a code letter for easy and accurate maintenance and repair.

The d.c. power circuit includes, in addition to the four generators and three batteries, 4 voltage regulators, 4 reverse current relays, 3 battery solenoids, and the power distribution busses. The 4 generator and 3 battery switches, 4 ammeters, voltmeter, and voltmeter selector switch are located on pilot's control panel on the left sidewall. The master ignition switch which turns off all battery power and grounds the ignition system to stop the engines, is located on the central control stand between pilot and co-pilot.

The three 34-amp.-hr. batteries are connected in parallel with the four engine-driven generators. The positive terminals of the batteries are connected to inboard nacelle junction shield busses by type B-4 solenoid switches, which in turn are controlled by three type B-5A battery switches on pilot's control panel. The battery switch circuits are protected by 15 amp. fuses in the inboard nacelle junction shields. The negative sides of the battery solenoids are grounded through the master ignition switch when the switch is on.

Output voltage of each generator is maintained at 28.5 v. by the voltage regulator. The load is equally divided among the generators by an equalizer coil in each voltage regulator. Each reverse current relay is adjusted to connect the generator to the power system when sufficient voltage has been built up, and to prevent battery discharge when the generator voltage falls below battery voltage by opening the circuit when approximately 10 amp. reverse current flows.

One ammeter for each of the four engine-driven generators is connected to a 50 mv., 300 amp. shunt in the generator relay shield in each nacelle. The shunt is inserted in the ground lead. A voltmeter controlled by a 4-position selector switch on pilot's control panel measures the voltage of any of the generators.

External power from a battery cart or portable generator may be supplied through a 3-prong receptacle in the lower side of the fuselage aft of the forward entrance door. A hinged door covers the box, which contains a 3-hole to 2-hole adapter plug for use with British equipment.

A fuse panel on the rear bulkhead of pilot's compartment contains 45 of the 77 fuses in the plane. In addition, the landing gear indicating relay is mounted on a bracket on the panel. A small auxiliary panel contains 5 fuses and control relay for the carburetor air filter motors, indicator lights, and switch; and 4 fuses for bomber's and pilot's windshield. Still another panel,

Landing Gear Data

Type oleo-pneumatic, single strut, retractable, three point.
Main gear tread width..... 21′ 1½″
Main gear wheel size (16 ply)..... 56″
Main gear oleo stroke..... 9–19/32″
Tail wheel size (10 ply)..... 26″

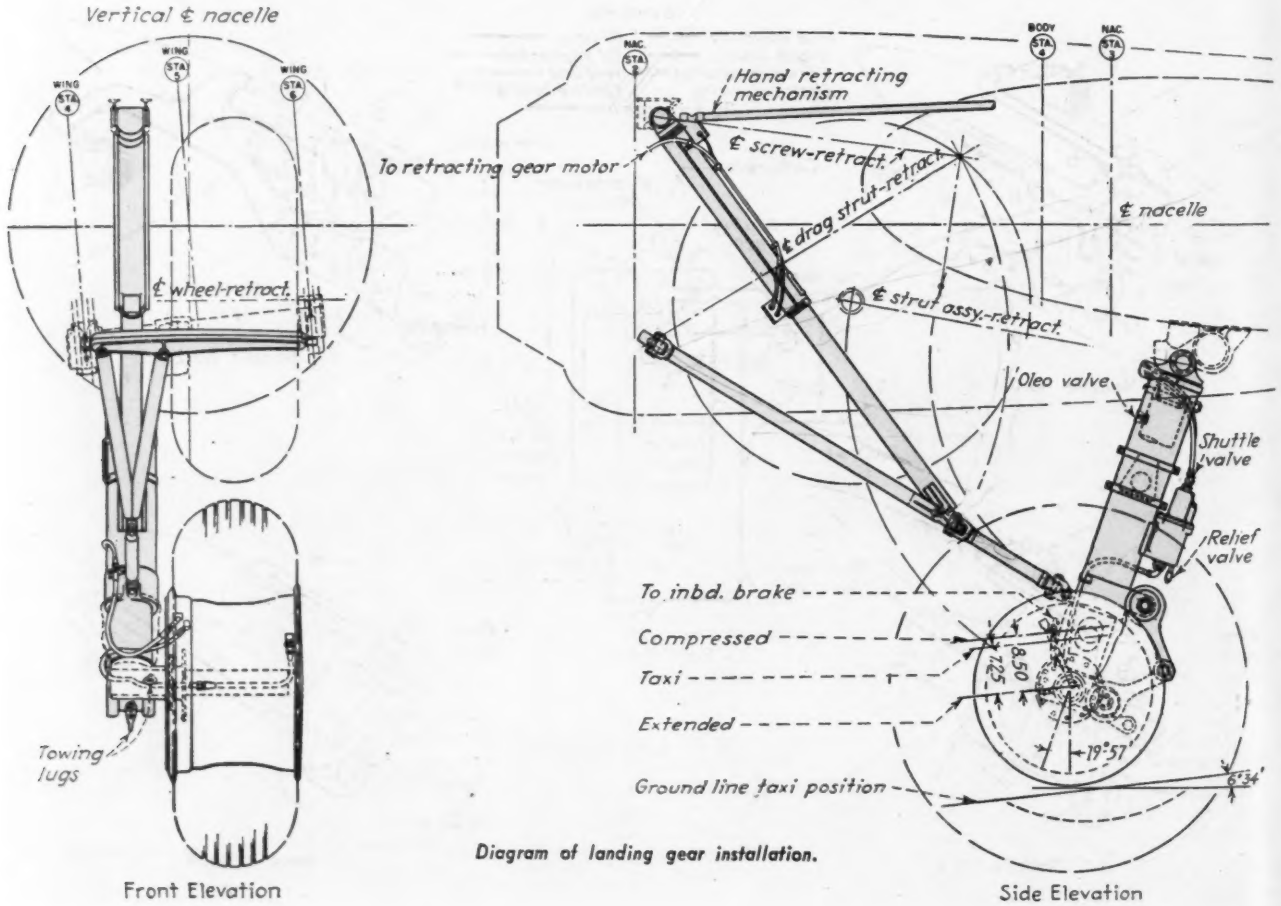
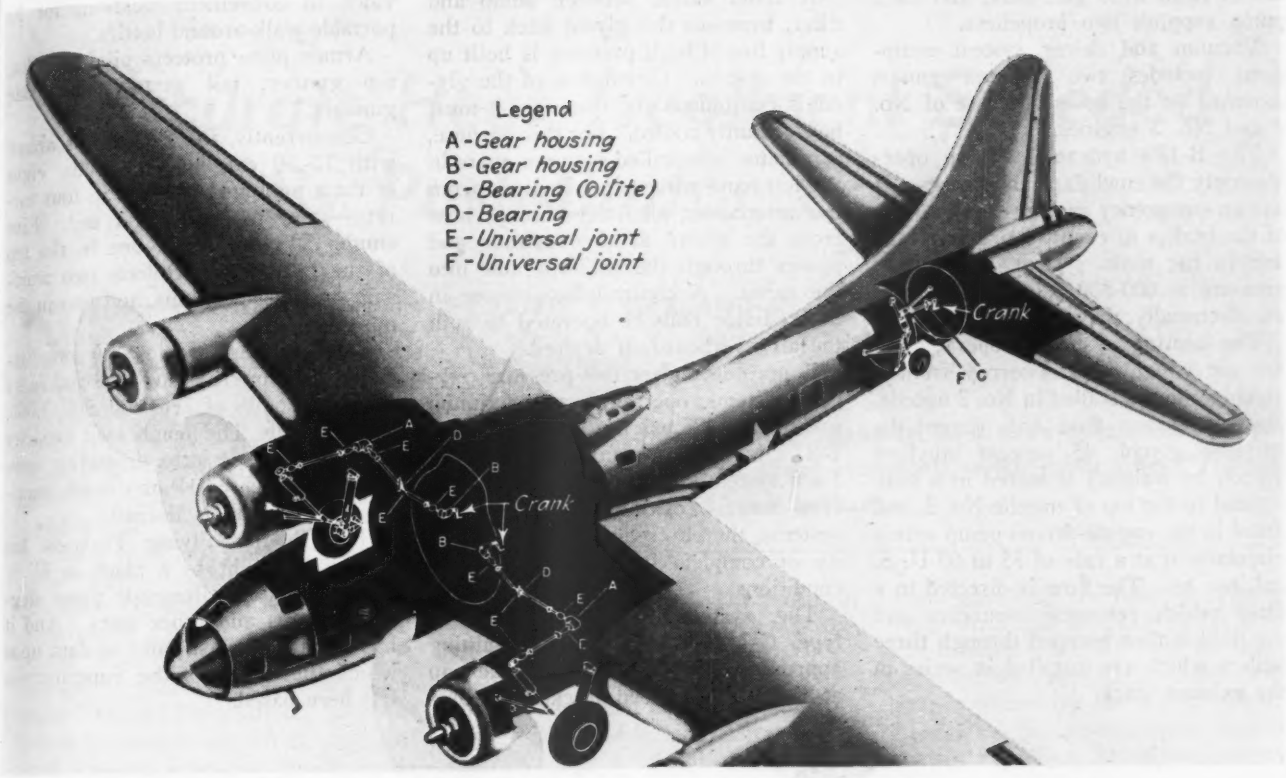


Diagram of landing gear installation.



Phantom view of landing and tail gear hand retracting systems.

beside the lower turret, contains 11 fuses for electrical and radio equipment in the rear portion of the plane.

Landing gear motors are all controlled by switches at pilot's station. The motors are mounted at the upper end of the retracting mechanism in the inboard nacelles, and receive unfused power through two solenoids and actuate the gear through a planetary 40:1 reduction gear, clutch assembly, and solenoid engaging mechanism.

Tail wheel retracting motor is mounted above the wheel and actuates it through a clutch and reduction gear, and solenoid engaging jaw. Means for manual control are also provided.

Bomb bay doors are actuated by a single motor mounted at the forward end of the bay, on the left side of the catwalk. Solenoids are mounted on an adjacent bulkhead. The doors may be opened with a hand crank inserted through a hole in the step at the forward end of the catwalk.

Other electrical circuits are: bomb control, deicer and pump, flight control, instrument, interior and exterior lighting, starter, propeller feathering, and warning signals. All are installed in open group rather than conduit to expedite repair of gunfire damage, in flight as well as on the ground. To increase reliability, duplicate circuits are provided for bomb controls.

The B-17 carries equipment for long and short range two-way voice and code communication: emergency transmission; reception of weather, range, and marker beacon signals; directional indication; and interphone communication between crew members.

In addition, some Flying Fortresses are equipped with instrument approach equipment.

Equipment normally installed is the following, or equivalent: Interphone—RC-36; command radio; liaison radio—SCR-287-A; radio compass—SCR-269-G; marker beacon—RC-43; and emergency radio—SCR-578.

Propeller anti-icing equipment consists of two electric-motor-driven fluid-metering pumps located beneath the radio compartment floor at the forward end of the camera pit. Fluid is ob-

Maximum Applied Flight Load Factors

Based on the following load factors and normal rated power for engines, negative margins of safety are .05.

Design gross weight (40,260 lb. bomb load 2,060 lbs.)	3.67 Pos. 2.0 Neg.
Maximum alternate weight (48,726 lb.)	2.92 Pos. 1.67 Neg.
Light alternate weight (34,900 lb.)	3.70 Pos. 2.06 Neg.

Applied Gust Factors

Design gross weight	
Flaps up	3.35 Pos. 1.67 Neg.
Flaps down	2.23 Pos. .29 Neg.
Maximum alternate weight	
Flaps up	2.92 Pos. 1.20 Neg.
Flaps down	2.01 Pos. .08 Neg.
Light alternate weight	
Flaps up	3.70 Pos. 2.06 Neg.
Flaps down	2.40 Pos. .52 Neg.

Maximum Applied Landing Factors

Gross weight (design gross weight, less bombs)	38,200 lb.
Landplane or ground landing	3.33
Gross weight (max. alternate weight, no reduction for bombs)	48,726 lb.
Landplane or ground landing	2.67
Maximum allowance overweight with flight restrictions, over	60,000 lb.

Limited Applied Diving Speed (Indicated)

305 mph..... 125% high speed at sea level.
This diving speed applied to all loading conditions up to and including alternate weight of 48,726 lb. (Applied loads must be multiplied by 1.5 to obtain design loads.)

Balance Factors

	Aft L.E. M.A.C.	Below Airplane C.L.
C. G. location... weight empty, wheels up	20.4% M.A.C...	10.9 in.
C. G. location, maximum design gross weight, wheels up	24.9% M.A.C...	10.6 in.
Most forward C.G. location. wheels down	21.4% M.A.C...	11.7 in.
Most rearward C.G. location.. wheels down	31.3% M.A.C...	8.7 in.

Other C.G. data:	
Most rearward allowable C.G. (flight)	35% M.A.C.
Most rearward allowable C.G. (landing)	35% M.A.C.
Most forward allowable C.G. (flight)	15% M.A.C.
Most forward allowable C.G. (landing)	20% M.A.C.

Useful Loads, Maximum Design

Crew (6)	1,200 lb.
Fuel tanks (with 734 gal. fuel)	4,404 lb.
Oil tanks (with 45.9 gal. of oil)	344 lb.
.50 Cal. machine guns (13)	1,043 lb.
.50 Cal. ammunition	about 1,500 lb.
Bombs, bomb shackles (2–2,000 lb.)	4,166 lb.
Residual fuel and oil	280 lb.
Total weight with useful load	48,726 lb.

tained from a 20 gal. tank, and each pump supplies two propellers.

Vacuum and deicer system equipment includes two vacuum pumps mounted on the accessory case of No. 2 and No. 3 engines.

The B-17's hydraulic system operates only the cowl flaps and brakes. It has an emergency system for operation of the brakes in event of pressure failure in the main system. Operating pressure is 600-800 psi., developed by an electrically driven pump.

The heating system is operated on hot air which is transferred from a glycol system installed in No. 2 nacelle. Heating system fluid (55 percent diethylene glycol, 45 percent ethylene glycol, by weight) is stored in a tank located in the top of nacelle No. 2, and flows to the engine-driven pump which circulates it at a rate of 55 to 60 U. S. gal. per hr. The flow is directed to a filter which removes impurities and the fluid is then pumped through three boilers which are installed in series in the exhaust stack.

A relief valve, between pump and filter, bypasses the glycol back to the supply line if high pressure is built up in the system. Circulation of the glycol is continuous and therefore it must be constantly cooled. For this purpose, a radiator is installed between spars in the left hand wing gap. Ram air from the intercooler air inlet absorbs heat from the glycol at the radiator and passes through the radiator and into the cabin. A controllable damper in the radiator may be operated to spill the air overboard, if desired.

Four independent low-pressure oxygen systems operating at maximum pressure of 425 psi. are provided, some B-17's having as many as 16 outlets. Each system supplies a portion of the crew and is separate from the other systems, thereby reducing the possibility of complete failure under combat conditions.

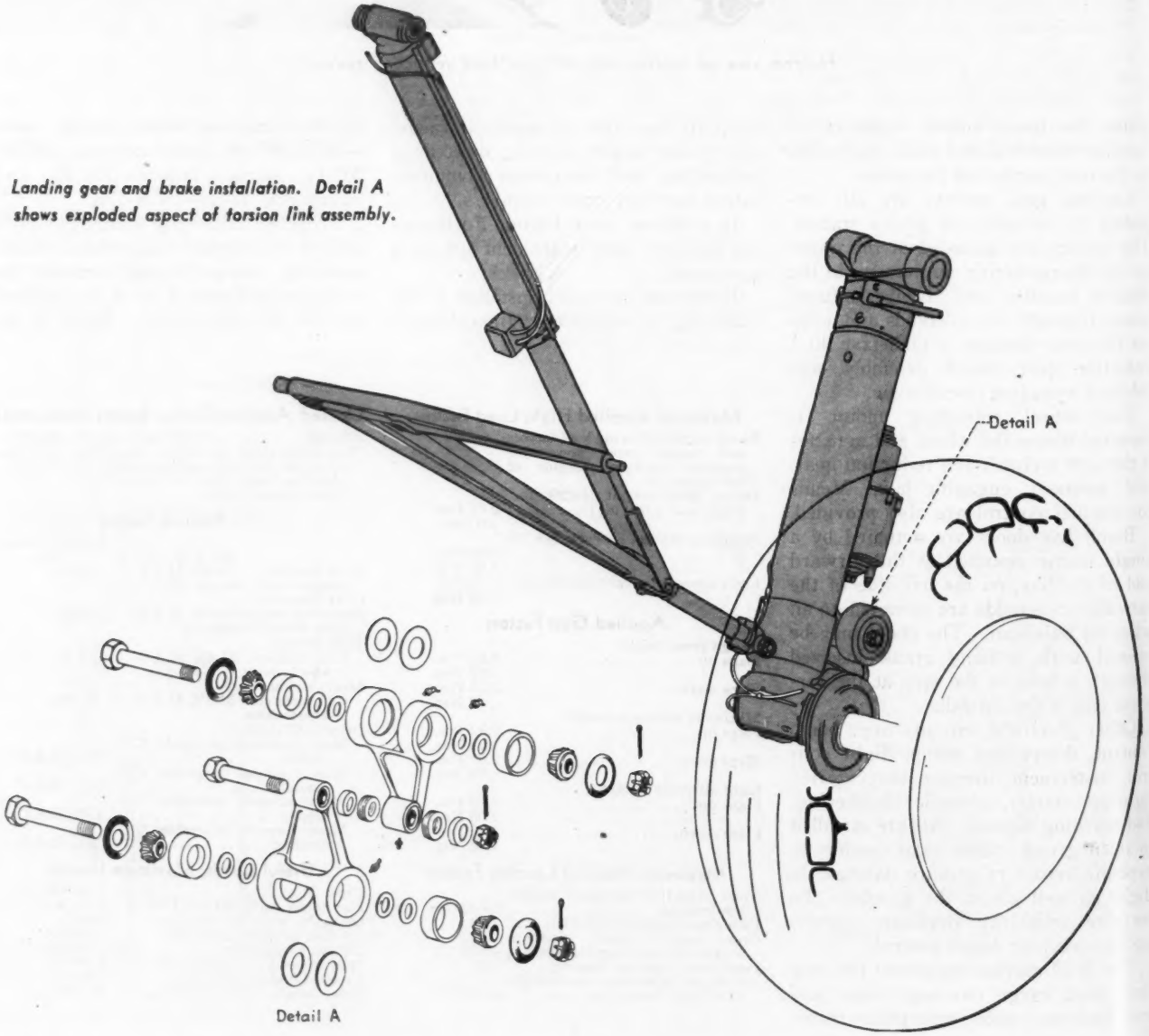
The system is supplied by 18 type G-1 bottles, each containing approximately 4-hr. supply for one man at 30,000 ft. Thirteen brackets are provided in convenient locations for 10 portable walk-around bottles.

Armor plate protects pilot, co-pilot, top gunner, tail gunner, and side gunners.

Concurrently, the Fortress is armed with 13-.50 cal. machine guns, eight of them arranged in pairs in four turrets—chin, top, ball, and tail. Five single .50's are fitted, one in the top of the radio compartment, two amidship or waist positions, and two in the nose section.

Bomb rackage varies but now includes both internal and external racks carrying bombs of 100, 300, 500, 1,000, and 2,000 lb. The bomb load capacity likewise varies greatly, depending upon the range desired. Range with maximum bomb load is limited.

The Boeing Flying Fortress has proven its right to a place in U. S. military history alongside those sluggers of this and other wars. And it has piled up a vast store of data upon which the design of the Superfortress has been based.



Landing gear and brake installation. Detail A shows exploded aspect of torsion link assembly.

Accurate Heat Treatment Speeded By Push-Button Control

By **JAMES F. CARLAND** *Industrial Control Specialist, General Electric Co., St. Louis, and*
P. R. WATSON, *Curtiss-Wright Corp., Airplane Div., St. Louis*

Saving time, material, and manpower, new oven automatically governs heat treatment of sheet materials, with labor effort reduced to mere operation of push buttons.

NEWLY INSTALLED EQUIPMENT for heat treating aluminum alloy sheets is speeding production at the Curtiss-Wright St. Louis plant. The need for this installation was predicated upon the necessity of producing load after load of aluminum alloy parts, uniformly heat treated to exacting specifications.

To accomplish this end, special features were incorporated whereby (1) spray quench reduces quenching distortion to a minimum, and obviates cutting floor for quench tank; (2) push-button controlled load truck eliminates manual operation, removes human variable in quenching, and provides a central operating position; and (3) precision temperature control eliminates "overshoot" when load is initially brought up to heat, and minimizes temperature fluctuations during soaking.

The furnace, the temperature control, and automatic conveyor with push-button control are supplied by General Electric, while the automatic spray-quench chamber was designed by Curtiss-Wright's plant layout department at St. Louis.

The furnace is 19 ft. 6 in. at its highest point (the top of the door-operating mechanism) and the furnace proper is 21 ft. long, while conveyor in front measures 37 ft., making overall length 58 ft.

Inside dimensions give room to accommodate a load truck approximately 5 ft. wide and 14 ft. long. There is 6-ft. clearance from truck top to top of door opening. Normal temperature for heat treatment of aluminum alloys is approximately 920 deg. F., but this furnace was designed for an ultimate temperature of 1,250 deg. F., so that it could be used for strain-relieving of steel assemblies.

Heating capacity was based on a load of 1,200 lb. of aluminum alloy and 900 lb. of steel truck and rack. This load can be heated from 70 deg. F., to 930 deg. F. within 25 min. if the furnace is already stabilized at 930 deg. F. before the load is moved in.

Total load of 600 kw. is divided into three separately controlled heating circuits arranged on hangers built into the furnace walls. Air heat transfer is supplied by four 28-in. motor-driven fans mounted on the top of the furnace, these fans re-circulating approximately 70,000 cu. ft. of air per min. down through the load and up past the heating units between baffle plates and the furnace walls. Side panels of the heat-resisting baffle can be removed and passed through the door of the furnace for inspection or replacement. A switch is connected to each fan shaft, so that if one fan stops, all heating circuits will open, protecting the units from burnout.

The lift-type door is operated by a two-speed motor hoist through two cable drums, one on each side of the door. The two-speed motor provides a slow-down, easing the shock of stop-

Fig. 1. Roller hearth electric furnace and allied equipment for heat treating aluminum alloy sheets at Curtiss-Wright St. Louis plant.

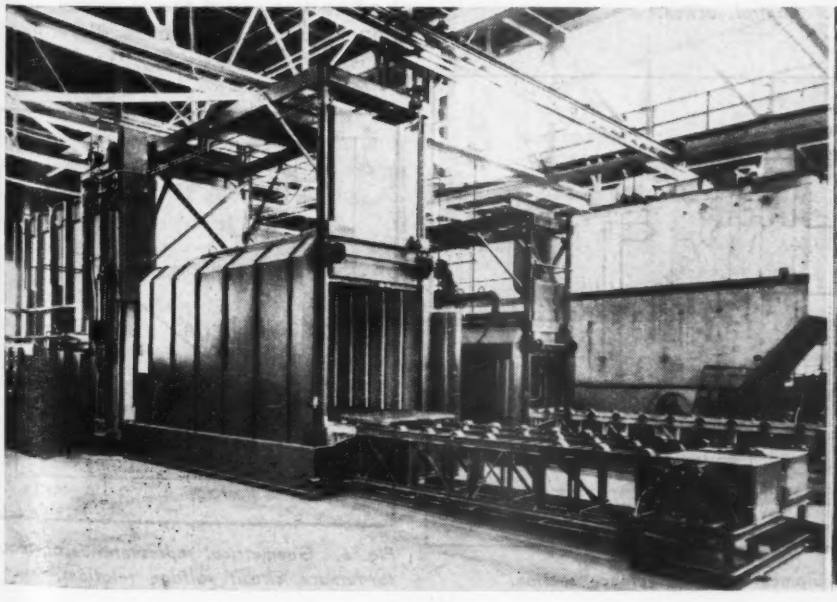
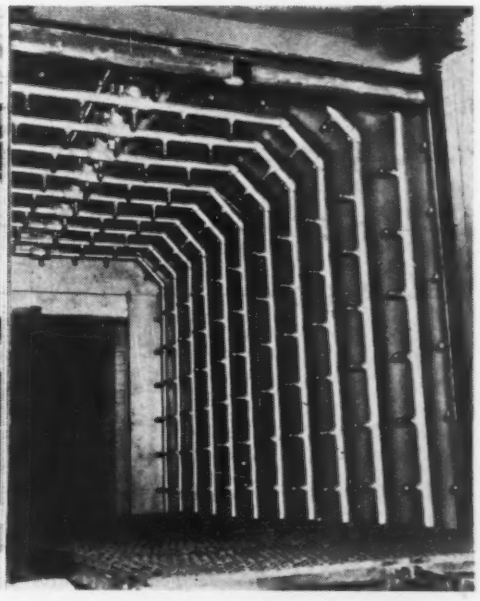


Fig. 2. Interior of jet quench, showing some of 300 nozzles on pipe loops.



ping. To prevent heat loss, the closed door is sealed by an air-operated clamp.

A series of rollers is provided to form a road bed for the load truck. There are three lines of these rollers (as shown in Fig. 1). Load is pulled in and out of the furnace by an endless chain, running over a drive sprocket at the outer end and an idler at the back.

The loading truck, operating from the loading station to the furnace and back through the quench, is made of heat-resisting alloy steel. The three channel frames of the truck ride on three roller tracks. The truck is in four sections to provide flexibility and to minimize distortion due to repeated heating and cooling while it is moved back and forth by the reversible two-speed electric motor. One end of the chain is fastened in front of the truck and passes over the driving sprocket, under the furnace, over the rear idler, through the furnace, and back to the truck.

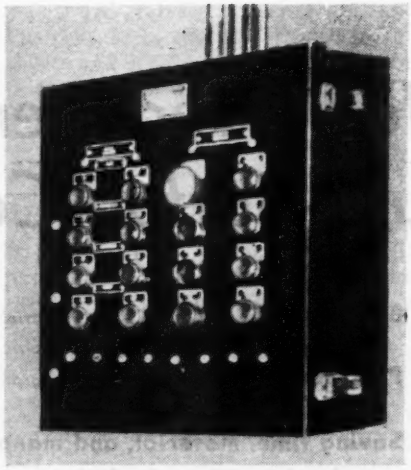


Fig. 3. Control panel with buttons for operating conveyor, furnace, quench doors, and quench valves.

Jet quench consists of 300 nozzles attached to pipe loops on a header, which is connected through a fast-acting valve to the water supply at 60 psi. Piping is enclosed by sheet metal, with a catch tank at the bottom. An idea of the internal construction can be gained by referring to Fig. 2. A pump returns water to the supply tank. Whenever water reaches 100 deg. F. after quenching, it is drained off and replaced with cool water. Approximately 2,000 gal. of water pass through the nozzles of each quench. The spray lasts for 30 sec.

Each end of the quench housing is fitted with a sliding door, electrically operated. Limit switches at top and bottom of the door-travel interlock its position with operation of furnace door, water valve, conveyor, etc.

Conveyor is controlled from a push-button station located near the front of the furnace (Fig. 3). The push-buttons initiate various operations, as follows: with truck loaded and ready for heat-treating, operator pushes the *Load to Furnace* button. Furnace door is hoisted to open position, stopping when it hits a limit switch. Simultaneously, conveyor motor is started and truck is moved through quench hood (doors are open except when quenching) and then into furnace until truck hits a limit switch. Motor then stops and the furnace door closes.

When the load has been sufficiently soaked at heat-treating temperature, it is ready for quenching. Operator then pushes the *Furnace to Quench* button, which opens furnace door. When door hits the *Open* position limit switch, conveyor motor pulls the load at high speed to the quench position, where it is automatically stopped

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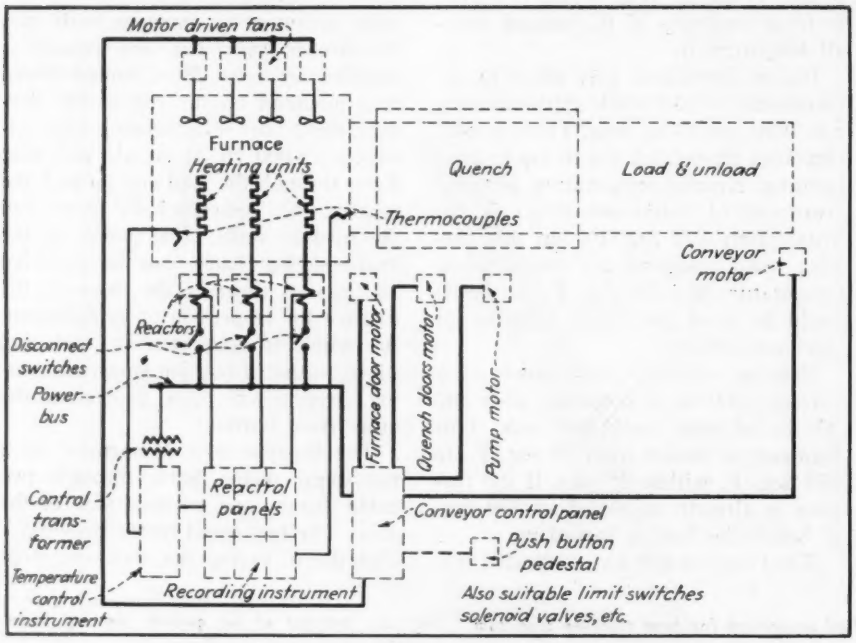


Fig. 4. Basic one-line wiring diagram, showing the principles of control action.

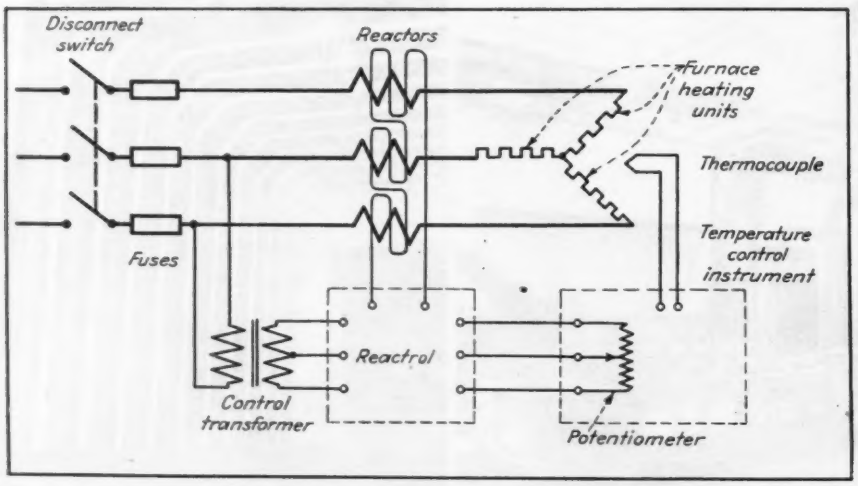


Fig. 5. Reactrol temperature control equipment for one furnace section.

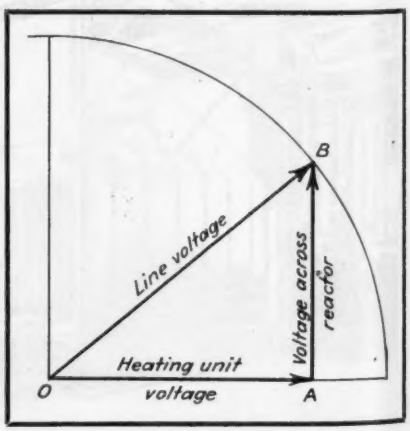


Fig. 6. Geometrical representation of reactor-furnace circuit voltage relations.

Optical Methods Ferret Transparent-Plastic Distortions

By **THOMAS GLADWIN,** *Engineer, Lockheed Aircraft Corp.*

How special scanning and sighting inspections have been devised to reveal hitherto-obscure imperfections in transparent enclosures —thus leading to fabrication of more-optically-accurate panels so our flyers can see better, shoot better, and bomb better.

ENORMOUS STRIDES have been made in the past three years in the development of forming and finishing methods for the fabrication of transparent aircraft enclosures. These enclosures have been made of transparents offered under several trade names and principally composed of methyl methacrylate.

Starting with many small panels mounted in intricate frames—essentially an adaption of glass window panes —designs have progressed to large enclosures entirely formed of the plastics. The ultimate expression of this trend to date is to be seen in the one-piece free-blown "bubble" canopies such as used on the Republic P-47 Thunderbolt and the North American P-51 Mustang.

These canopies also represent an almost complete solution of one of the worst difficulties which confronted early efforts in this field—optical distortion. The first large all-plastic transparent assemblies were noses for medium bombers—which contained so much optical aberration that severe eyestrain and discomfort resulted as well as inaccuracy in nose-gun sighting.

While many types of enclosures are not suited to free-blown forming, methods of vacuum forming via lubricated dies have progressed to such a point that very satisfactory optical results may be expected from enclosures of almost any contour.

Generally speaking, thicker material and deeper draws tend to increase distortion. Visual requirements which are critical in only one portion of the enclosure's surface may sometimes also be met by free-blowing (vacuum drawing to contour, like a bubble, without die contact) a portion of the assembly and cementing it to the remainder.

An example of this work is the Boeing B-17's new nose (recently developed by the writer and Swedlow Aeroplastics) whose free-blown upper half is utilized by the chin turret sight, while the lower half retains the special contour required by the bombardier window.

Though advances in technique have gradually improved the product, checking methods have lagged behind. Outside of special test setups for small samples, inspection of production parts has usually been visual. To check an enclosure, the inspector peers through it at an illuminated grid (Fig. 1), also he sights along the surface for irregularities.

For non-critical windows, this method may be sufficient; but it is seldom adequate in other applications. Consistent results and definite standards can only be maintained by more precise methods, paralleling the use to which the product will be put. Inspection requirements and specifications should duplicate, as far as possible, the optical system and conditions under which the enclosure will operate. These applications are basically of two types: Sighting or scanning.

Sighting panels: Examples are Martin upper turrets, Boeing B-17 nose, Boeing B-29 sighting blisters, and astrodomes used on virtually all bombers. For other than general scanning by the operator, the optical system utilizes only a very small portion of the surface of this enclosure at any one time. A single line of sight passes through the sighting instrument, through the formed plastic sheet, and on to its objective. We are therefore concerned with the deflection of this ray of light as it passes through the various portions of the surface which lie within the sighting area.

An additional factor is also pertinent: In almost all such installations the sighting instrument is so con-

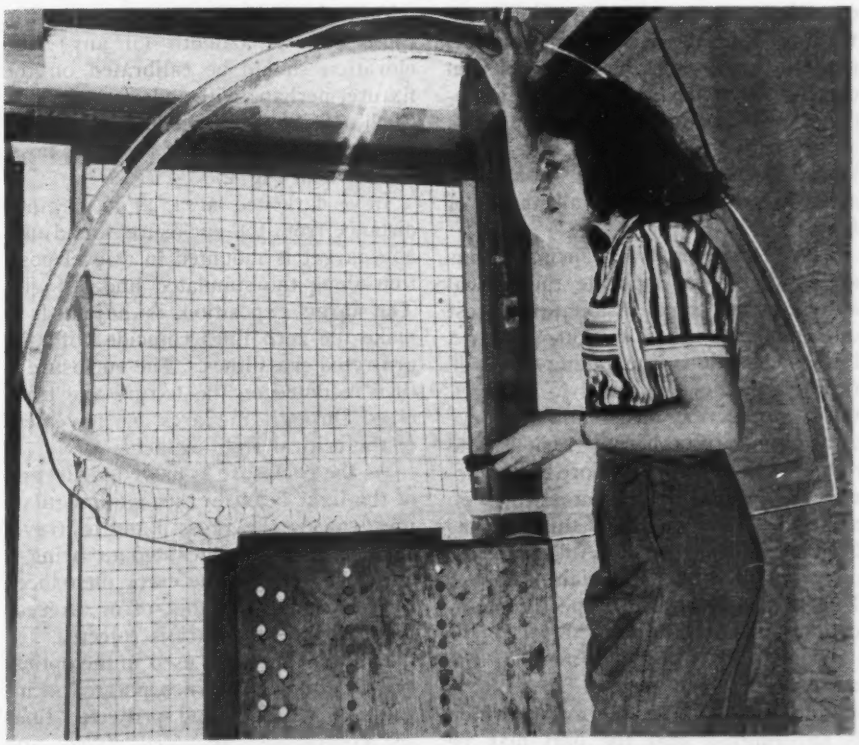


Fig. 1. Visual inspection, using squared screen, merely locates the more obvious imperfections. ("Dick" Whittington photos)

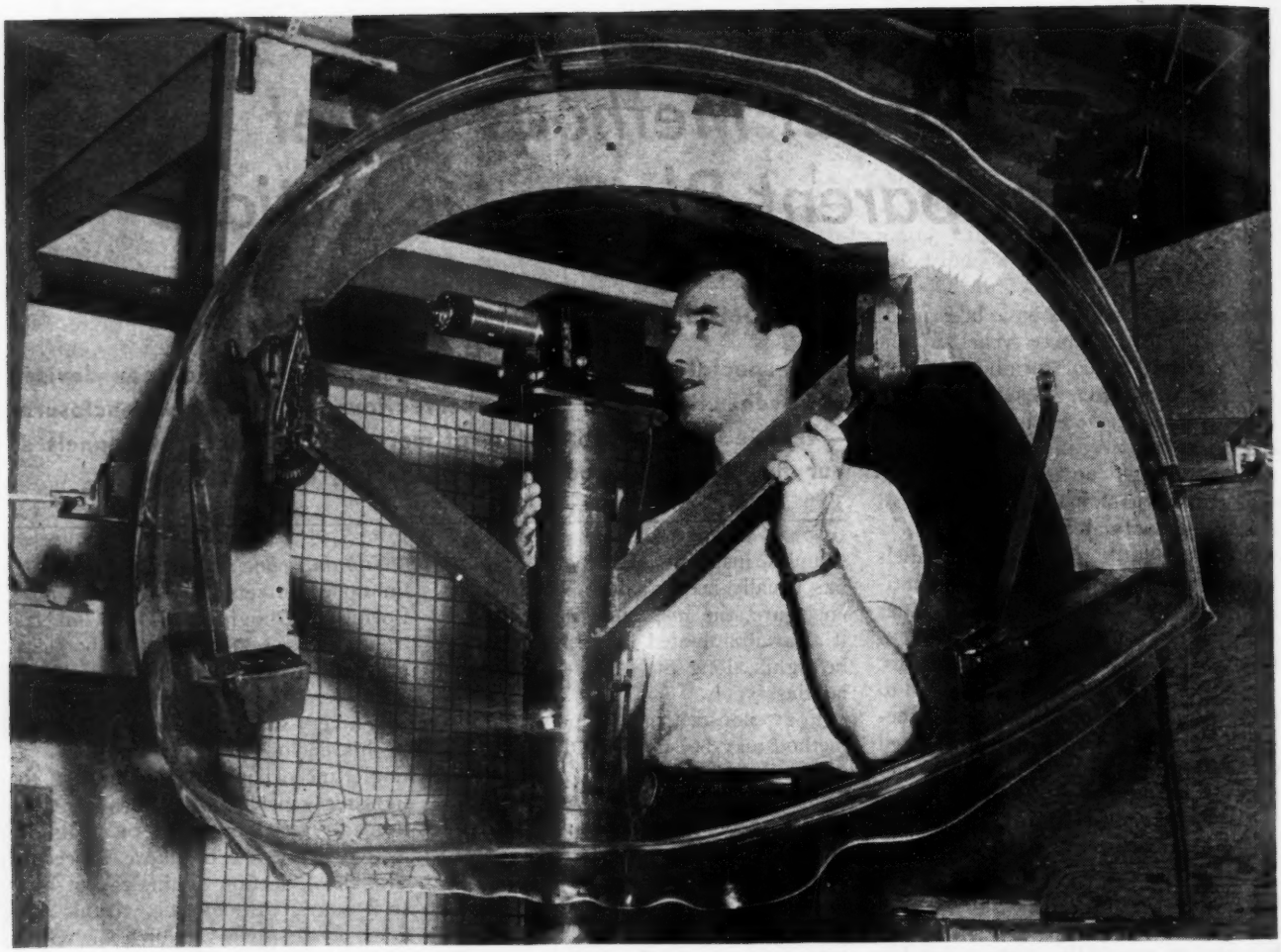


Fig. 2. Projection method uses projector which indicates smallest distortion of vision. Note rack and pin on left of fixture for elevation-test settings.

structed that it is adjustable, in some cases having a progressive adjustment, varying with its orientation, to compensate for predictable variations in direction of deflection (e.g., the astrodome). In armament applications, this adjustment (referred to as bore-sighting or harmonizing) usually comprises a single setting to cover all angles of fire.

For a test setup, two principal means are available to duplicate the optical system of the actual installation. Most obvious is the use of a sight, usually a low-power rifle 'scope, taking a "bead" through the formed panel to a target. On a production basis, however, eye strain and fatigue become serious, and results may be achieved more economically through projecting cross-lines on a target. A procedure of this sort has been established by the American Society for Testing Materials (ASTM D637-41T), though this specific application is confined to flat sheet.

Using the projection method, the enclosure, or a portion thereof, is mounted upon a movable fixture which is so designed that the part may be swung, in relation to the light beam, through arcs of movement duplicating the arcs traversed by the sight mounted within the enclosure. Movement in these arcs as azimuth (if any) and elevation should be calibrated on the fixture, perhaps with indexing devices. Such a fixture, designed by the writer for the upper portion of the B-17 nose, is shown in Fig. 2.

In a darkened area, at a specified distance from the enclosure, an adjustable target is mounted in a level position along the simulated line of sight. The target's position is adjusted to make the zero lines coincide with the projected cross lines. The enclosure is then mounted on the fixture and traversed through the arcs of movement of the critical sighting field.

As the enclosure is moved, deflection of the light beam by surface irregularities causes the cross lines to travel about the target, the amount being a direct measure of the error introduced by distortion. If this error exceeds the tolerance, the part is rejected.

If bore-sighting is used in the optical system, this may be incorporated in inspection. Target and projected lines are coordinated as noted above, and the part is mounted on the fixture in any convenient position in relation to the line of sight. It will then be seen that the location of the projected lines on the target has been altered. This datum deviation is recorded, and the target is moved to coincide again with the cross lines in zero position.

Inspection proceeds as before, variation from zero lines being noted with regard to tolerances. Before each enclosure is set up for examination, the target must be reset to zero. Datum deviation, recorded on stickers, will be used as a correction factor, if the enclosure is to be bore-sighted before installation. In this way the error introduced by optical distortion may be considerably reduced.

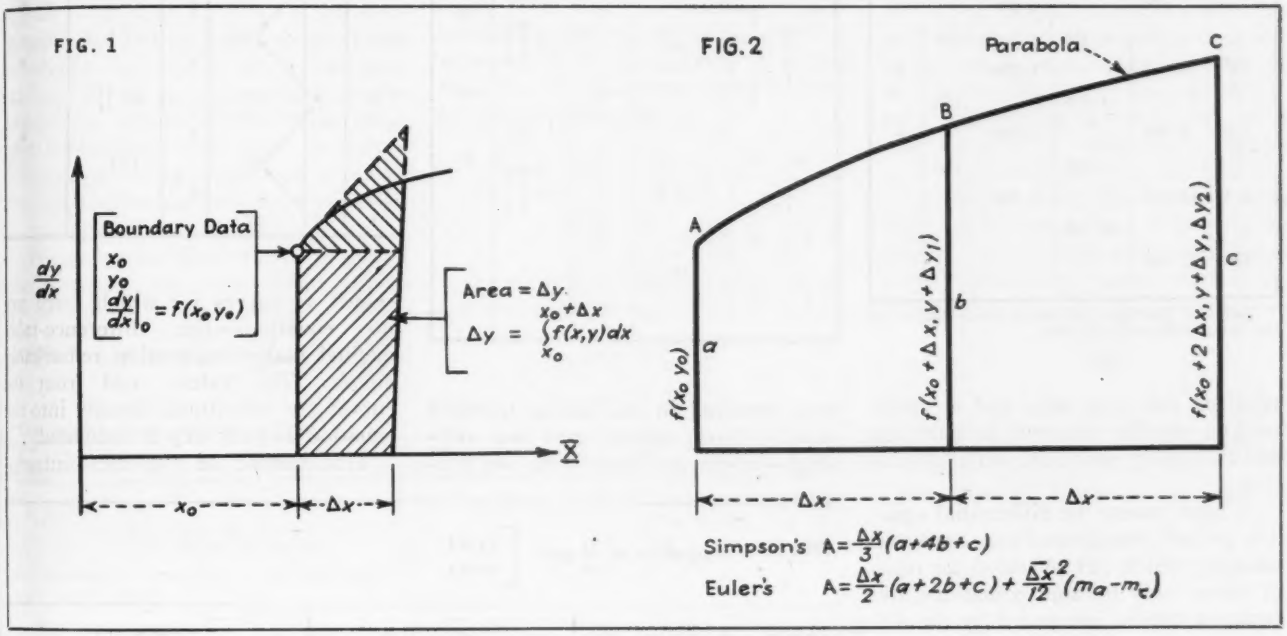
Scanning Panels: The best examples of this type of design currently in production are pursuit airplane canopies, especially those employed on the Republic P-47 and North American P-51 previously mentioned. All windows not used as sighting panels also come under this classification, though their optical properties are seldom sufficiently critical to warrant rigorous checking of production parts.

The real problem here is essentially one of controlling localized aberrations.

(*Turn to page* 254)

Simplified Numerical Integration For Design Engineers

PART I



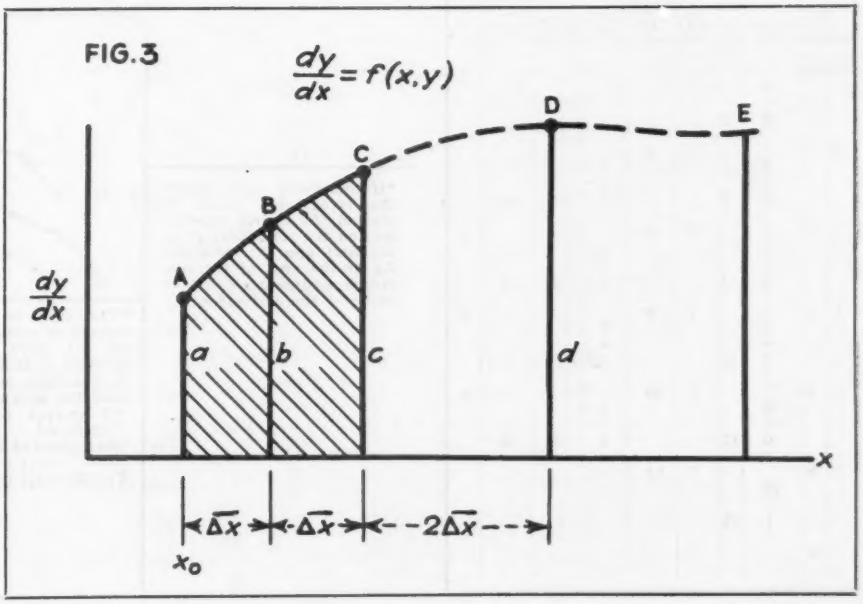
By G. L. SHUE, *Ph.D., Development Engineer, Consolidated Vultee Aircraft Corp.*

Use of difference-table method in solving differential equations indicates advantageous uses in varied aircraft design calculations.

DIFFERENTIAL EQUATIONS which can be solved only by approximation methods are frequently encountered in the design of aircraft, and, generally, the final approximations are the result of a series of highly complicated calculations.

At Convair we have managed to simplify the process of solving differential equations by means of a difference-table method for numerical integration. This method has been used with considerable success in compressibility and heat anti-icing equations, and there is every reason to believe that it can be advantageously employed in solving other problems.

The difference-table method reduces the work of solving differential equations to a simple matter of adding entries in a suitable table. One calculation, using the differential equation, is



Normal Difference Table For $y = x^3$

FIG. 4

x	y	Δ	Δ^2	Δ^3	Δ^4
0	0				
		.125			
.5	.125		.750		
		.875		.750	
1.0	1.000		1.500		0
		2.375		.750	
1.5	3.375		2.250		0
		4.625		.750	
2.0	8.000		3.000		0
		7.625		.750	
2.5	15.625		3.750		
		11.375			
3.0	27.000				

Note that the third differences are constant and the fourth differences are zero.

Modified Difference Table $\begin{bmatrix} y = x^3 \\ \frac{dy}{dx} = 3x^2 \end{bmatrix}$

FIG. 5

x	y	Δ		Δ^2		Δ^3			Δ^4
		$\Delta y/\Delta x$	Δ	$\Delta(\Delta)$	$\frac{\Delta(\Delta)}{\Delta x}$	$\frac{}{\Delta x}$	$\Delta(\Delta^2)$	$\frac{\Delta(\Delta^2)}{\Delta x}$	
0	0	$\frac{0}{0}$	0						
0	0			1	2				
		$\frac{1}{1}$	1			$\frac{1}{3}$	2	6	
1	1			2	4				0
		$\frac{0}{0}$	3			$\frac{2}{3}$	4	6	
1	1			4	8				0
		$\frac{7}{1}$	7			$\frac{1}{3}$	2	6	
2	8			5	10				0
		$\frac{0}{0}$	12			$\frac{2}{3}$	4	6	
2	8			7	14				
		$\frac{19}{1}$	19						
3	27								

FIG. 6 $\begin{bmatrix} y = x^3 \\ \frac{dy}{dx} = 3x^2 \end{bmatrix}$

x	y	Δ	Δ^2	Δ^3	Δ^4
0	0				
		$\frac{dy}{dx} = 0$			
0	0		1		
		1		1 = 1	
1	1		2		0
		$\frac{dy}{dx} = 3$		$2 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$	
1	1		4		0
		7		1 = 1	
2	8		5		0
		$\frac{dy}{dx} = 12$		$2 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$	
2	8		7		
		19			
3	27				

FIG. 7 $\begin{bmatrix} y=x^3 \\ \frac{dy}{dx}=3x^2 \end{bmatrix}$

x	y	$\Delta = \frac{dy}{dx}\Delta x$	Δ^2	Δ^3	Δ^4
0	0	0			
			1		
		1		1=1	
			2		0
1	1	3		$2=\begin{bmatrix}1\\1\end{bmatrix}$	
			4		0
		7		1=1	
			5		0
2	8	12		$2=\begin{bmatrix}1\\1\end{bmatrix}$	
			7		0
		19		1=1	
			8		
3	27	27			

required for each step, and a simple method can be followed in checking and correcting each individual calculation.

In cases where the differential equation yields a complicated transcendental solution, which can be solved for pairs of values only by approximations, the equation can be integrated by the difference-table method so as to provide a set of uniformly spaced pairs of values very useful in curve plotting. In problems involved in calculating terminal velocity dives, takeoff, and heat anti-icing—where the basic data are presented as curves for which there are no equations—the difference-table method makes integration remarkably simple. The values read from the curves are substituted directly into the equation as each step is computed.

This method of numerical integra-

FIG. 8 Integration of $\frac{dy}{dx} = x^2$ $\begin{bmatrix} x_0 = 1 \\ y_0 = 6 \end{bmatrix}$

TABLE II-A $\frac{dy}{dx} = x^2 = y^1$

x	y	$\Delta = y^1 \Delta x$	Δ^2	Δ^3	Δ^4
1	6	1			
2	?	4			
3	?	9			
4	?	16			

*If this entry were known the integration could be started. As a first approximation try zero. This gives the first approx. value for Δy as the area of the rectangle assuming a constant value of the derivative.

TABLE II-B

x	y	Δ	Δ^2	Δ^3	Δ^4
1	6	1			
			0		
2	7	4		$6=\begin{bmatrix}3\\3\end{bmatrix}$	
			3		0
3	20	9			

*This value is in error. To correct it assume an error of +1 here and work through as indicated by the superscripts in II-C. Note that the assumed error of +1 causes an error of +12 in Δ^4.
The corrected Y-values are:
$Y_2 = 7 - \frac{1}{12}(-16) = 8.333$
$Y_3 = 20 + \frac{1}{12}(-16) = 14.667$

TABLE II-C

x	y	Δ	Δ^2	Δ^3	Δ^4
1	6	1			
			+1		
		1		−2	
			0		
		1		3	
			−1		0
2	7	4		$6=\begin{bmatrix}3-2\\3-2\end{bmatrix}$	
			−5		+12
		9		−16	
			−5		+10
		13		−13	
			+5		
		20	−4		
3					
1	6	1			
			1.333		
		2.333		.334	
			1.667		0
2	8.333	4		$\begin{bmatrix}.334\\.333\end{bmatrix}$	
			2.334		−.001
		6.334		.332	
			2.666		+.001
3	14.667	9		$\begin{bmatrix}.333\\.334\end{bmatrix}$	
			3.333		0
		12.333		.334	
			3.667		
4	27.000	16			

Note: The analytical solution of this equation is:

$$Y = \frac{17 + x^3}{3}$$

tion is analogous to Simpson's One-Third Rule in that it employs direct numerical computations. Actually, it uses Euler's Quadrature Formula. The relationships between the variables are illustrated in Fig. 1.

In the general case it is not possible to draw the curve for $dy/dx = f(x, y)$, since y must be known. Therefore, the idea of successive approximations must be used. If a very small value for Δx is chosen, then Δy is nearly the same as the area of the rectangle with base Δx and altitude $dy/dx = f(x_0, y_0)$. Thus it becomes possible to find an approximate value of $dy/dx = f(x_0 + \Delta x, y_0 + \Delta y_1)$ and to recompute Δy, which now includes the small triangle. From this, the derivative curve may be extrapolated for a short distance so as to include another Δx, and the area added is an approximation of Δy_2.

We now have three values of x and the corresponding approximate values of y—i.e., (x_0, y_0), $(x_0 + \Delta x, y_0 + \Delta y)$, $(x_0 + 2\Delta x, y_0 + \Delta y_1 + \Delta y_2)$. Therefore, we can compute three values of dy/dx and find a better approximation of y by Simpson's One-Third Rule, or by Euler's Quadrature Formula, as indicated in Fig. 2.

Having found this better approximation for y, we are now ready to extrapolate another small amount and repeat the computations. We used $2\Delta x$ as the unit each time, obtaining the results shown in Fig. 3. The shaded area is already found, and the curve through A, B, and C is quite accurately determined. This curve is extended to D, where $dy/dx = d$, and the added area under the curve is found by Euler's Formula:

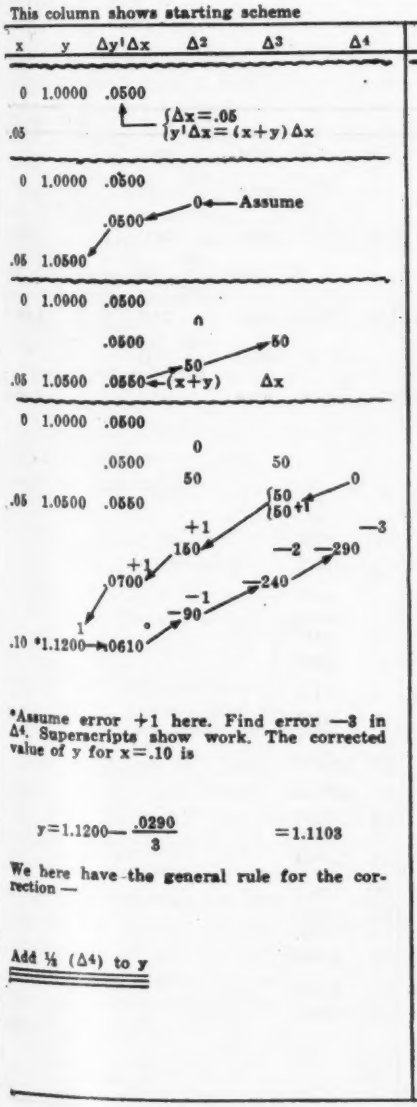
$$\Delta y = \text{Area} = \frac{2\overline{\Delta x}}{2}(c + d) + \frac{(2\overline{\Delta x})^2}{12}(m_c - m_d)$$

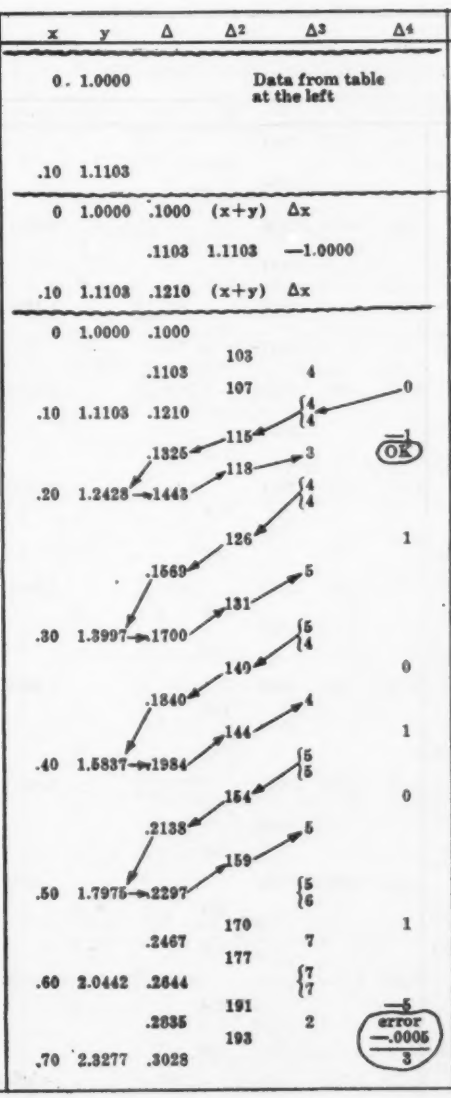
Point D is corrected by computing a better value for d after the first approximation for this point is found. The curve is then extrapolated another $2\overline{\Delta x}$ to E and the process is continued, using Euler's Formula and correcting point E, if necessary, until the required range in x has been covered.

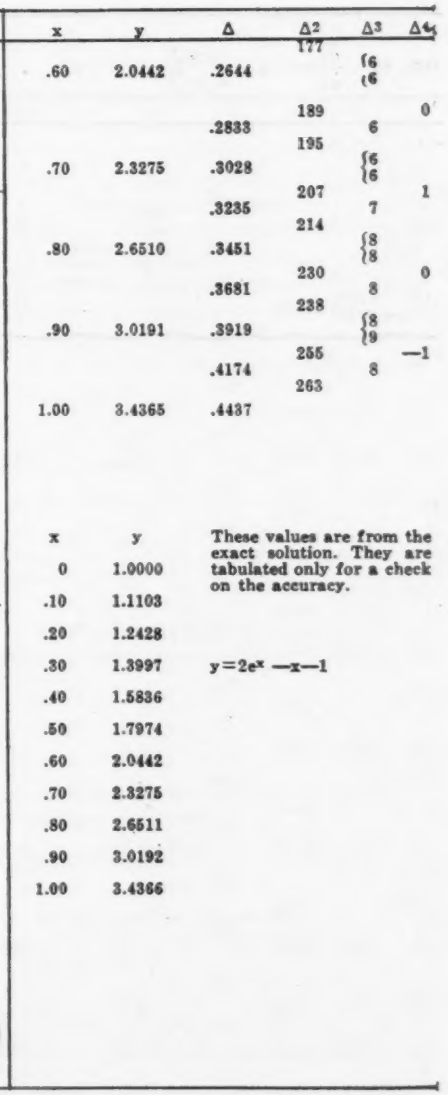
Naturally, if the above process is followed literally, the work is somewhat lengthy. However, it can be set up in the form of a difference table in which the formulas are automatically applied and the work easily done.

The difference table is tabulated so that each column gives the difference of the values in the column on the left. If the tabulated function is of the nth degree, the nth differences will be constant and the $(n + 1)$th differences will be zero. A difference table for $y = x^3$ is shown in Fig. 4. This is a so-called "normal" difference table, since all of the values of Δx are the same. If the values of x are not uniformly spaced, a modification is re-

FIG. 9 Integration of $\frac{dy}{dx} = x + y$ $\quad x_0 = 0$, $y_0 = 1$


This column shows starting scheme
x y Δy'Δx Δ² Δ³ Δ⁴
Δx=.05
y'Δx=(x+y)Δx
Assume
(x+y) Δx
*Assume error +1 here. Find error −3 in Δ⁴. Superscripts show work. The corrected value of y for x=.10 is
y=1.1200 − .0290/3 =1.1103
We here have the general rule for the correction —
Add 1/3 (Δ⁴) to y





quired in accordance with the following:

(1) In the Δ-column, tabulate $\frac{\Delta y}{\Delta x}$.

If $\Delta x = 0$, then $\frac{\Delta y}{\Delta x}\Big|_{\Delta x = 0} = \frac{dy}{dx}$ from the definition of a derivative.

(2) In the Δ^2-column, tabulate the quotient of the differences in the Δ-column by the average of the two Δx-values involved. If it still results in the form of 0/0, tabulate d^2y/dx^2.

(3) In the Δ^3-column, again divide by the average Δx-value.

(4) Continue as in (3).

The difference table shown in Fig. 5 may be modified as indicated in Fig. 6. Every other entry in Δ^3, beginning with the second, is considered a double-deck entry, and one of them only is used for obtaining Δ^4. It is better to eliminate the duplicates of the x and y entries, as indicated in Fig. 7. Thus, the Δ-column may contain the equivalent of Δy, or:

$$\Delta y = \frac{\Delta y}{\Delta x}\Delta x = \frac{dy}{dx}\Delta x.$$

It should be observed that working to the right in a difference table is the equivalent of differentiation; conversely, working to the left is integration. For applying Simpson's One-Third Rule, the derivative is a second degree function (parabola) in the Δ-column, and the Δ^4 column is zero.

For an example of the use of a difference table in numerical integration, let us take an equation in which Simpson's One-Third Rule is exact while the derivative is a function of x only:

$$\frac{dy}{dx} = x^2 \qquad x_0 = 1, \quad y_0 = 6$$

From this, the values of y corresponding to x-values of 1, 2, 3, and 4 should be tabulated as shown in Fig. 8.

For an example in which the derivative is a function of both x and y, the following might be used:

$$\frac{dy}{dx} = x + y \qquad x_0 = 0, \quad y_0 = 1$$

The numerical integration of this equation is shown in Fig. 9 by means of a step-by-step process which illustrates the method and ease of reading. In the second step, the value of Δ^2 is lacking. Since Δx is a small value, it is reasonably valid to assume zero and then continue. This is the equivalent of using the area of the rectangle, as explained previously.

The method of making the corrections in Fig. 9 always leads to the same correction (add 1/3 Δ^4). This is based on the tacit assumption that a slight change in y will make no change in $y' \Delta x$, a fact which is usually true if Δx is not too large. It is a good rule to choose Δx of such size that $y' \Delta x$ is unchanged within the required accuracy by changes in the last digit of y.

If Δx is chosen too large, the correction rule fails and two or more computations for each pair of values are necessary. In such case, it is easier to start with a smaller value of Δx, since two pairs of entries could be found for an equal amount of work.

Change in boundary conditions is handled by a change in the original entries in the table. For example, the latter equation, with new entries is solved in Fig. 10:

$$\frac{dy}{dx} = x + y \qquad x_0 = 0, \quad y_0 = 0$$

(To be concluded next month)

FIG. 10 $\frac{dy}{dx} = x + y$ $\begin{cases} x_0 = 0 \\ y_0 = 0 \end{cases}$

x	y	Δ	Δ²	Δ³	Δ⁴	dy/dx
0	0	0				
						x + y
		0		.0025		
			.0025		0	
.05	0	.0025		.0025		.05
			.0075	.0025		
		.0100		−.0120	−.0145	
			−.0045		error	
					−.0048	
.10	.0100 / −.0048	.0055				.1100
0	0	0				
			52			
		.0052		1		
			53		1	
.10	.0052	.0105		4 = 12/12		.1052
			57		0	
		.0162		2		
			59		0	
.20	.0214	.0221		4 = 12/12		.2214
			63		1	
		.0284		3		
			66		0	
.30	.0498	.0350		4 = 12/12		.3498
			70		0	
		.0420		2		
			72		0	
.40	.0918	.0492		5 = 12/12		.4918
			77		0	
		.0569		3		
			80		0	
.50	.1487	.0649		5 = 13/12		.6487
			85		1	
		.0734		3		
			88		0	
.60	.2221	.0822		6 = 13/13		.8221
			94		1	
		.0916		4		
			98		−1	
.70	.3137	.1014		6 = 13/13		1.0137
.70	.3137	.1014		6 = 13/13		
			104		1	
				1118		4	
			108		0	
.80	.4255	.1226		7 = 14/13		1.2255
			115		1	
				1341		4	
			119		0	
.90	.5596	.1460		8 = 14/14		1.4596
			127		0	
				1587		4	
			131		1	
1.00	.7183	.1718		10 = 15/15		1.7183
			141		−1	
				1859		4	
			145			
1.10	.9042	.2004		10 = 15/15		2.0042
			155			
				.2159		6	
			161		0	
1.20	1.1201	.2320		11 = 16/15		2.3201
			172		0	
				.2492		5	
			177		1	
1.30	1.3693	.2669		13 = 16/17		2.6693
			190		0	
				.2859		7	
			197		0	
1.40	1.6552	.3055		13 = 17/16		3.0551
			210		0	
				.3265		6	
			216		2	
1.50	1.9817	.3482		15 = 17/18		3.4818
			231		1	
				.3713		9	
			240		−1	
1.60	2.3530	.3953		16 = 18/18		3.9530
			256		+1	
				.4209		9	
			265		2	
1.70	2.7739	.4474		18 = 19/19		4.4739
1.70	2.7739	.4474		18 = 19/19		
			283		.0	
				.4757		10	
			293		0	
1.80	3.2496	.5050		20 = 110/110		5.0496
			313		0	
				.5363		10	
			323		1	
1.90	3.7859	.5686		23 = 111/112		5.6889
			346		−1	
				.6032		11	
			357			
2.0	4.3891	.6398				6.3890

x	y
0	0
0.1	.0052
0.2	.0214
.3	.0499
.4	.0918
.5	.1487
.6	.2221
.7	.3138
.8	.4255
.9	.5596
1.0	.7183
1.1	0.9042
1.2	1.1201
1.3	1.3693
1.4	1.6552
1.5	1.9817
1.6	2.3530
1.7	2.7739
1.8	3.2498
1.9	3.7859
2.0	4.3891

Solution is $y = e^x - x - 1$

FROM Mach Number TO True Airspeed

By RICHARD G. SMITH,
Experimental Flight Engineer, Pratt & Whitney Aircraft Div., United Aircraft Corp.

Given here is a convenient series of nomographs providing a simple method for computing true airspeed—with pertinent Mach number employed as the successive factor.

TRUE AIRSPEED, which is a factor of primary interest in airplane flight testing, has never been easy to calculate accurately. The reading of the airspeed indicator must be accompanied by readings of pressure altitude and air temperature, and these must be corrected for instrument errors. Also, airspeed and altitude readings must be corrected for errors resulting because the pitot static tube is not usually subjected to true static pressure.

A further correction must be made to the air temperature reading because impact of the thermometer against the air results in a local temperature rise. In the past, this correction has been rather laboriously made. The impact temperature rise is a function of true airspeed, but the true airspeed can only be approximated unless the corrected temperature is known.

Having finally determined the corrected temperature, however, the true airspeed can be calculated by multiplying the indicated airspeed by an air density factor and another factor to correct for increased compressibility of air at altitudes above sea level.

The Mach number, a parameter of interest in itself for performance testing, has been found to be a useful tool in computing true airspeed by a method somewhat less tedious than those used in the past.

The relationship of the Mach number to indicated airspeed and pressure altitude must first be considered:

$$M = 2.23607 \sqrt{\left(1 + \frac{\Delta P}{P}\right)^{.2857} - 1}$$

where M = Mach number
ΔP = dynamic pressure
P = atmospheric pressure

This equation has been solved by means of the nomograph shown in Fig. 1, in which ΔP is represented by the indicated airspeed and P by pressure altitude. By aligning the indicated airspeed and the pressure altitude on the proper scales, the Mach number may be read on its scale.

The Mach number is also related to the true airspeed by the following equation:

$$M = \frac{V}{C}$$

where V = true airspeed.
C = speed of sound.

The speed of sound in air depends only upon the air temperature, and it may be computed from:

$$C \text{ (in mph.)} = 44.84 \sqrt{T}$$

where

T = air temperature, deg. C., absolute.

The true airspeed, Mach number, and air temperature are related, then, by the equation:

$$V = 44.84\, M \sqrt{T}$$

This equation has also been solved nomographically, as shown in Fig. 2.

To use Fig. 2, however, it is necessary to know the air temperature. The observed temperature must be corrected for the temperature rise due to impact. This correction is greatly facilitated by use of the Mach number. It can be shown that:

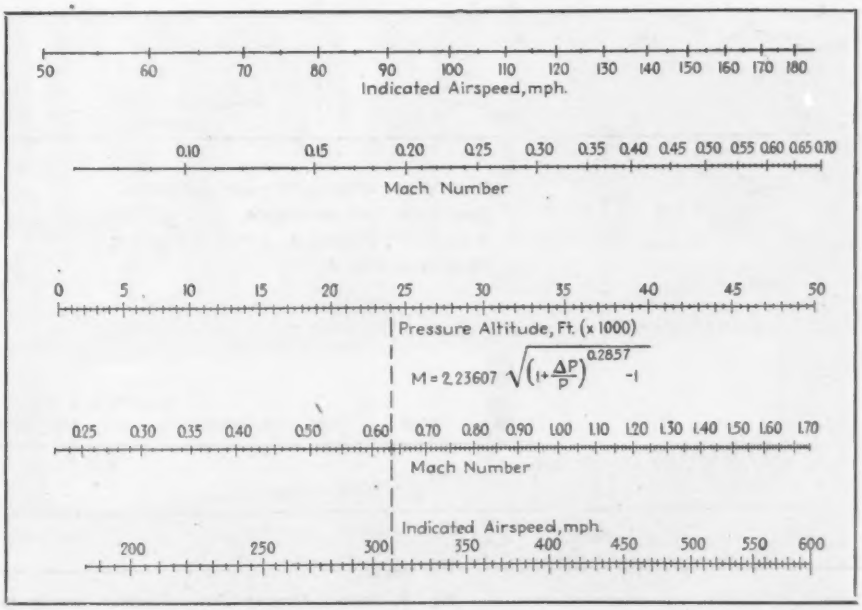
$$\frac{T_o}{T_s} = 1 + \frac{KM^2}{5}$$

where

T_o = observed air temperature, absolute.
T_s = static air temperature, absolute.
K = impact constant.

The value of K, which depends upon the shape and location of the temperature-measuring device, may be determined by a speed-course calibration if the temperatures observed on the speed course are plotted against the square of the true airspeed to yield a straight-line curve. Extrapolation of this curve to zero airspeed will yield the static air temperature, and the slope of the curve will determine the value of impact constant, K.

Fig. 1. Mach number nomograph.



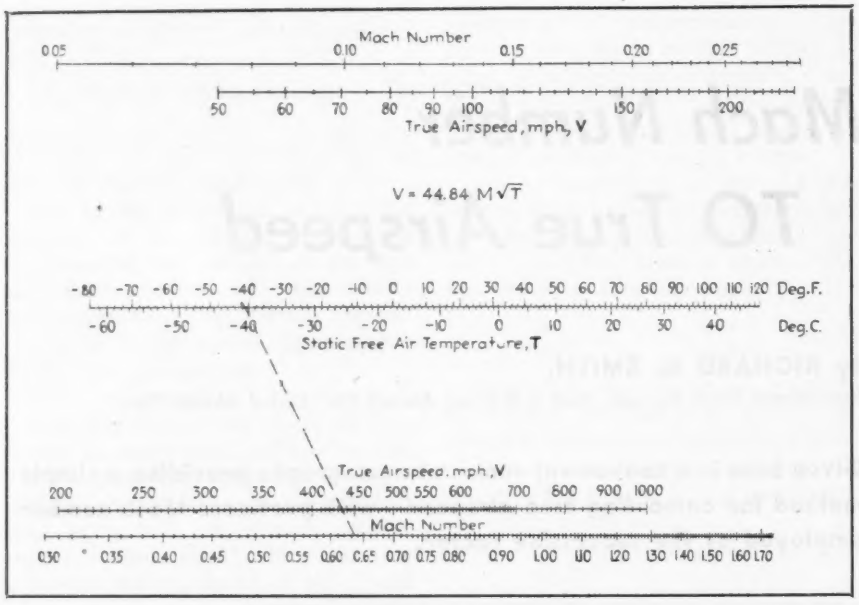


Fig. 2. True airspeed nomograph.

This is readily understood when it is seen that, for an adiabatic compression—

$$\Delta T = 1.781\ V^2 \times 10^{-4}$$

and for the actual compression,

$$\Delta T = 1.781\ KV^2 \times 10^{-4}$$

where ΔT = impact temperature rise, deg. F.

The nomograph shown in Fig. 3 provides a convenient method of correcting the observed air temperature if the value of K is known—as it must be to accurately calculate the true airspeed. When K is unknown, a value of 0.65 may be used as a reasonable approximation.

Use of these nomographs can best be illustrated by an example. The following data (corrected for instrument and pitot static position errors) are obtained during a flight test:

Indicated airspeed, 310 mph.
Pressure altitude, 24,000 ft.
Free air temperature, −25 deg. C.

Value of K for the airplane has been found by speed-course calibration to be 0.83.

Using the nomograph shown in Fig. 1, 310 mph. indicated airspeed is aligned with 24,000 ft. pressure altitude, and the Mach number is found to be 0.635. In Fig. 3, the K value of 0.83 is aligned with this Mach number and the temperature ratio is found to be 1.067 on scale A. This ratio is now aligned on scale A_1 with the free air temperature of −25 deg. C. on scale B, and the static air temperature is read on scale C as −40.5 deg. C. In Fig. 2, this temperature is now aligned with Mach number 0.635, and the true airspeed is found to be 434 mph.

Convenience attained through this nomographic method is evident. But it must be noted that careful calibrations of pitot-static position errors and instrument errors must be applied to indicated airspeed, altitude, and temperature data if use of these nomographs is to yield accurate true airspeeds.

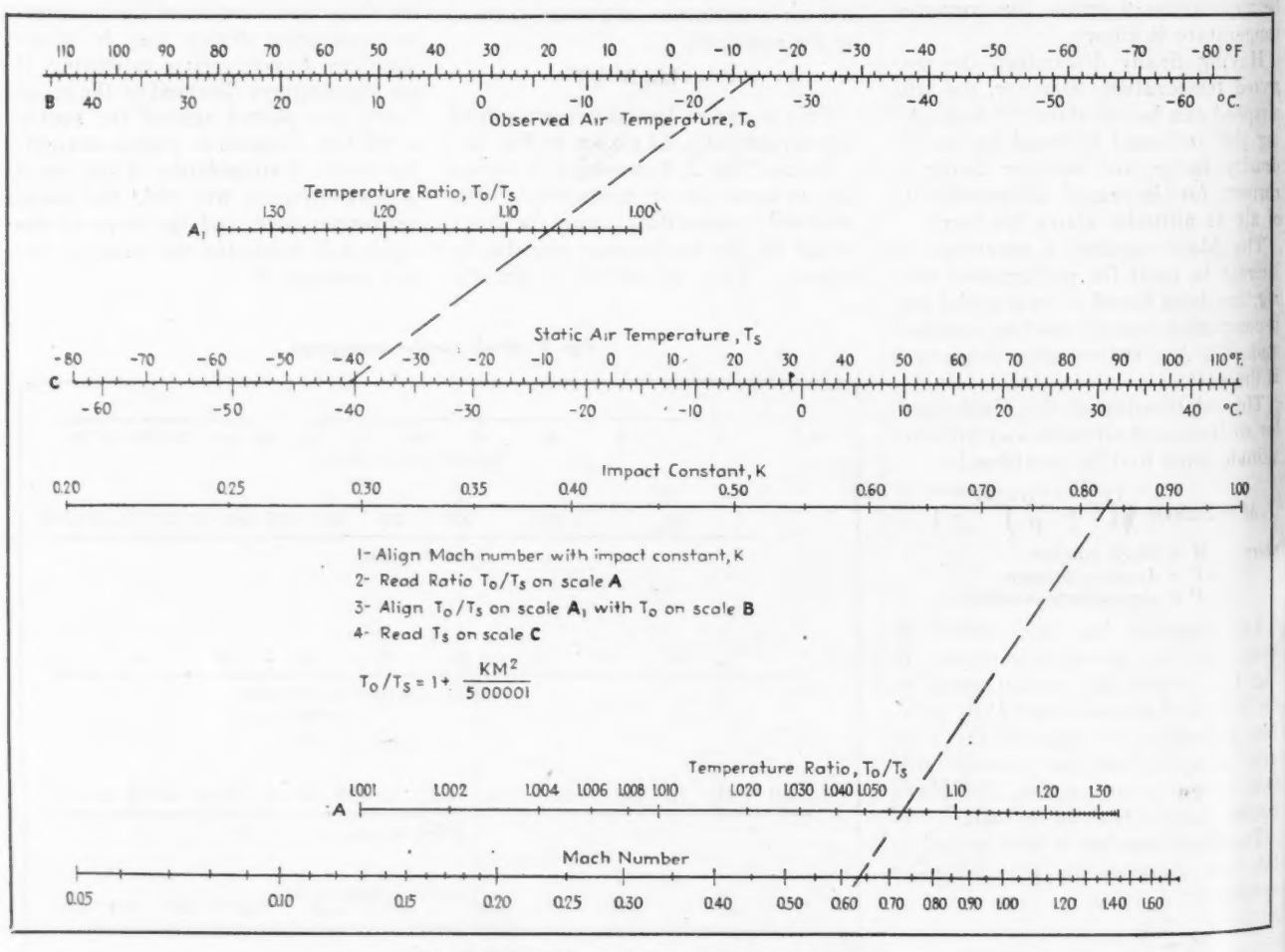
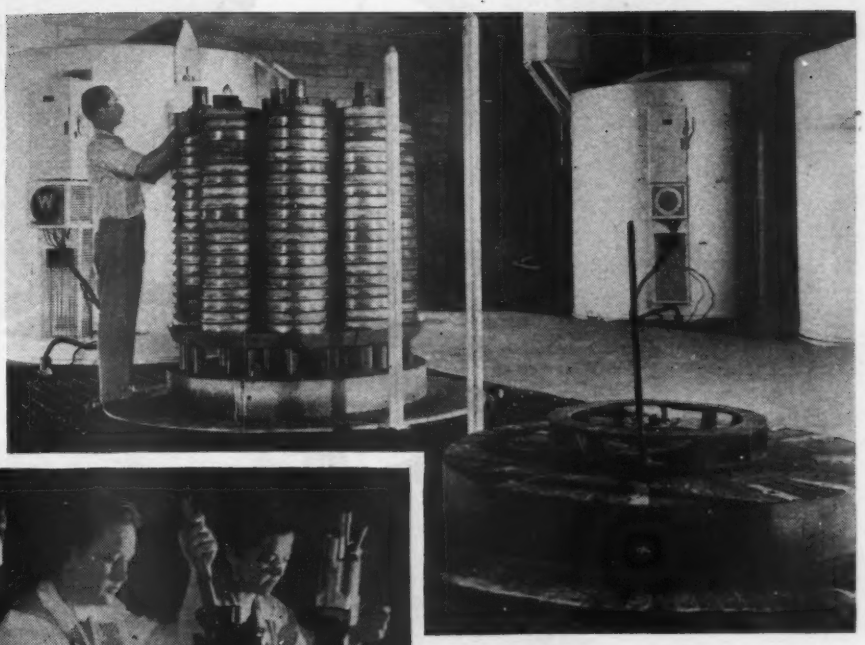


Fig. 3. Impact temperature correction nomograph.

Large Nitriding Plant At Engine Factory

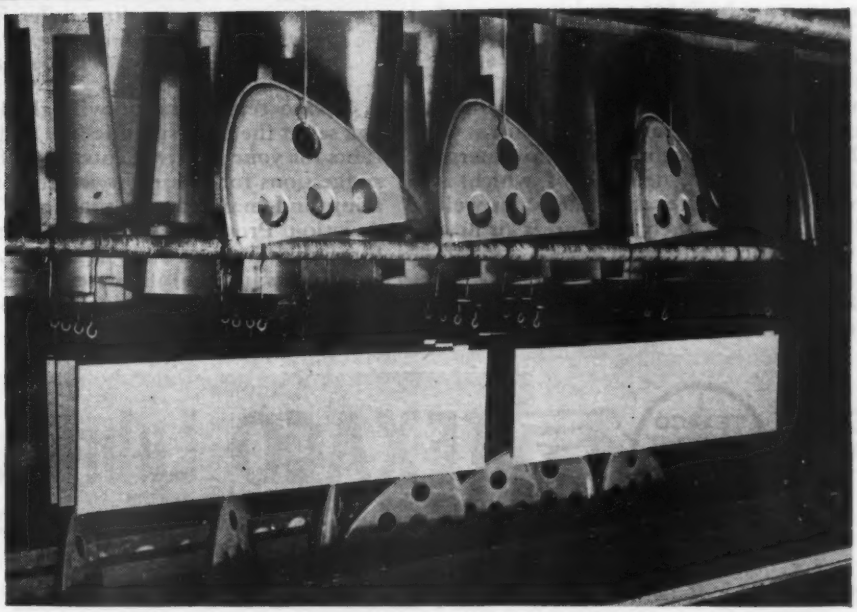
• Wright Aeronautical has just had installed (by Westinghouse) a battery of 58 bell-type nitriding furnaces, one of which is shown here with a load of internal gears, ready for application of bell (rear), which covers charge and retains heat and gases. New furnace reduces ammonia consumption by over 50 percent and gives better control over depth of hardness.



PLANT-PRACTICE HIGHLIGHTS

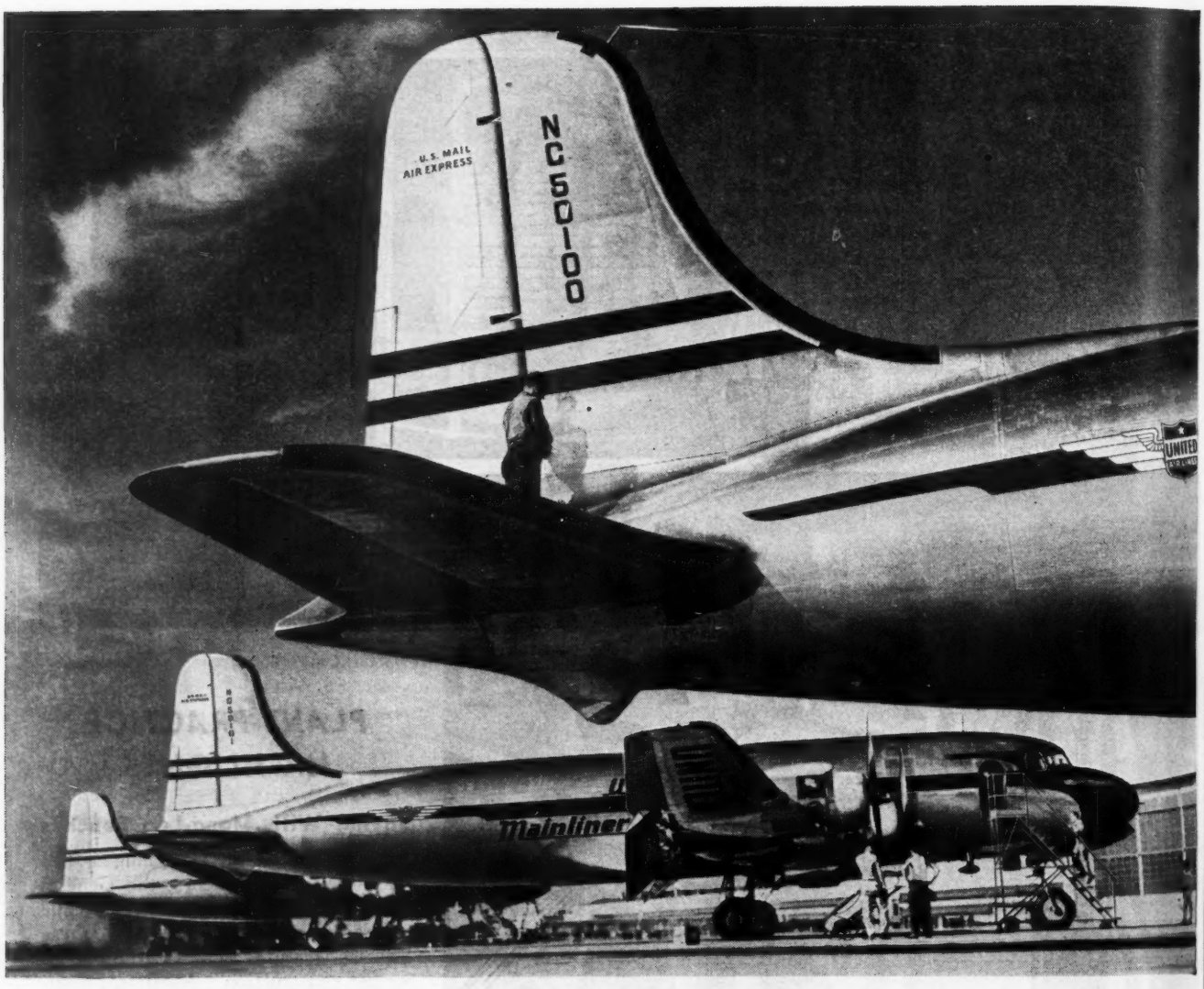
Saving With Mono-Leg Benches

• By using single-leg flanged-steel Masonite-topped benches, the General Electric Co. saved much material while affording more room. And these benches feature same sturdiness as former construction. Additional economy is in spacing of workers, now no longer hampered by bench legs at edge of table. Bench's narrow top (22 in.), while wide enough for working space, doesn't provide extra room to invite cluttering, thus improves efficiency.



Dip Conveyor Speeds Painting

• At Goodyear's Akron plant, engineers have devised a new time-saving conveyor for paint shop. Parts are carried suspended from racks, which dip vertically into tank, then carry parts to end of line, where they are removed and replaced by others. Parts similar to those shown in picture move forward at about 24 in. per min. Larger pieces are moved more slowly.



CRUISING SPEED...5 MILES A MINUTE!

PLANNING ahead for new speed, comfort and efficiency in postwar air travel, United Air Lines has already ordered 50 planes of the type shown in the photo — four-engined DC-4's and DC-6's. The latter are built for a cruising speed of 300 mph., with accommodations for 56 passengers. Their 5-mile-a-minute speed will cut the non-stop Chicago-New York run to 2 hours, 40 minutes, will reduce coast-to-coast flying time to 8¾ hours.

These new super-luxury "Mainliners" and "Cargoliners", delivery of which is expected to start later this year . . . as well as the other ships of United's great air fleet . . . will fly lubricated with *Texaco Aircraft Engine Oil* exclusively.

Texaco was chosen by United Air Lines after extensive service experience had proved its dependability and economy as an aircraft engine lubricant. In joining other aviation leaders in the use of Texaco, United adds emphasis to the fact that —

More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

A Texaco representative will gladly help you select the most suitable fuel and lubricants for your requirements...and furnish suggestions for the improvement of operating and maintenance practices. Texaco Aviation Products are available to you through more than 2300 Texaco distributing points in the 48 States. The Texas Company, *Aviation Division*, 135 East 42nd Street, New York 17, N. Y.

RECONVERSION RUSTPROOFING

5 Points to Remember

1. Upon termination of war contracts, Government-owned production equipment must be rustproofed promptly, in accordance with *official instructions.*
2. Ordnance Specification P.S. 300-A contains *official instructions* for the complete processing of such equipment.
3. These instructions require that only rustproofing materials meeting Government specifications be used.
4. *Texaco rustproofing products meet Ordnance specifications for application on Government-owned equipment.*
5. For full information, see your Texaco representative or write us.

TEXACO

TEXACO Lubricants and Fuels

FOR THE AVIATION INDUSTRY

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON SUNDAY NIGHTS ★ METROPOLITAN OPERA BROADCASTS SATURDAY AFTERNOONS

Valve Servicing Demands Special Technique*

With the perfection, over many years of invention and experimentation, of modern aircraft engine valves, have come parallel needs for special precision in servicing these uniquely constructed units.

A SHORT DESCRIPTION of the steps taken to develop the modern aircraft engine valve, may help the mechanic to understand better the reasons for using a more complicated service system than is favored for automotive engines.

Because of three conditions, considerably more demands are put upon the aircraft engine valve than are put upon its automotive brother. First of all, bmep. runs about twice as high—often 200 psi. Then, the high lead content of the fuel causes deposits of thick, liquid lead oxide on the valve heads. This oxide may get onto the seat, causing pitting, until finally the surface of the valve is "guttered" or grooved and the torch-like action of the burning gases completes the ruin of the part. And finally, the engines operate for many hours at high speed, without that occasional letup which does much to lengthen the life of automotive valves.

Evolution of the modern valve is well shown in Fig. 1, where the steps in improving a Wright Cyclone valve are illustrated.

Heat transference from the head of the valve is graphically depicted in Fig. 2 where, strangely enough, the total range of temperature is nearly the same in both inlet and exhaust valves.

To counteract the effects of corrosion on the head and seat, valves are frequently coated with chrome nickel (Figs. 3a and 3b) and in most instances they have a Stellite or hardenable steel tip on the stem to prevent excessive wear at that point. Fig. 3d shows a valve to which a Stellite seat has been applied.

Cooling is obtained by using sodium in the hollow stem of the valve. This metal (use of which for this purpose was first discovered by S. D. Heron of the Ethyl Gasoline Corp.) melts in the hot valve head and carries the heat to the stem, where it is dissipated into the cylinder head.

First hollow valves were made by forging the head with copper in the center, afterward melting out the copper. Then this somewhat crude method was improved upon, until the modern valve is forged exactly to blueprint dimensions.

Seat inserts, formerly made of bronze, gave much trouble until the adoption of TPA and Silchrome X-9 steels (Figs. 4 and 5).

We are indebted to English engineers for Austentitic steel, Stellite,

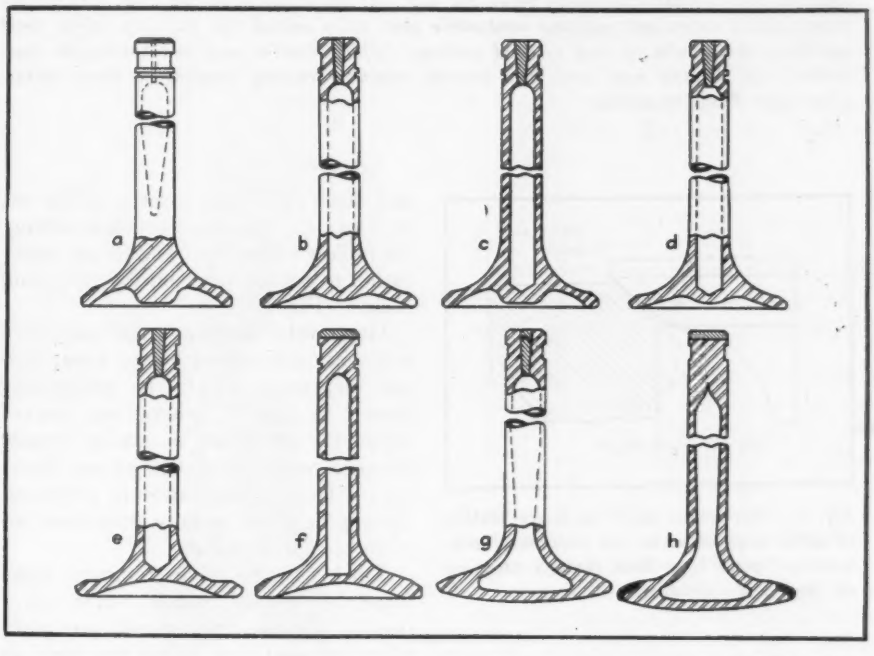


Fig. 1. Evolution of Wright Cyclone engine valves, Initial type (a), of cobalt chrome, had no slat but was drilled for lightness only. Later models (b), (c), and (d) were salt cooled, while remainder were cooled by sodium. Present hollow-head type (h) has honed and nitrided stem, Stellite seat, and cobalt chrome welded tip. Note that button design was discarded in later models. (Thompson Products).

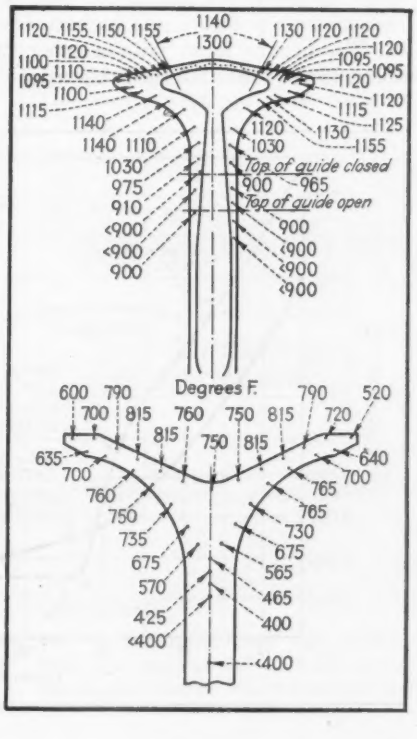


Fig. 2. Exhaust valve (top) and inlet valve (bottom) temperatures, showing range of nearly 400 deg. in each valve.

* AVIATION acknowledges with thanks the cooperation afforded, in the preparation of this article, by the various firms mentioned here in text and captions.

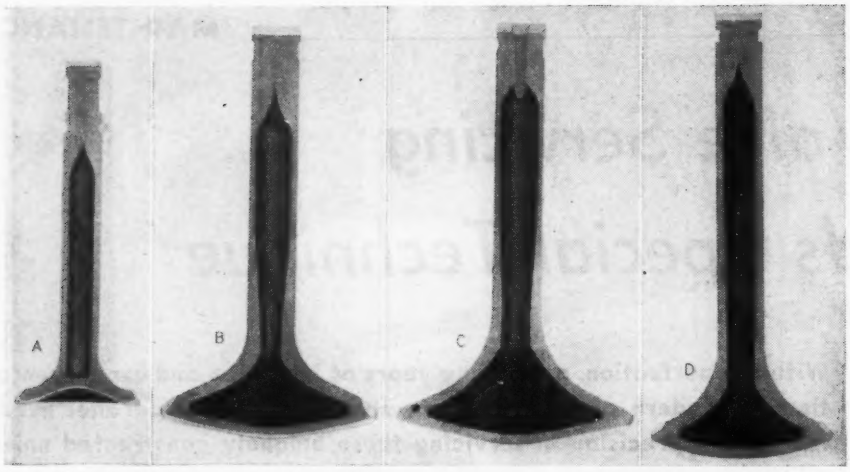


Fig. 3. Modern aircraft engine valves. Type (a) has hollow stem, Stellite tip, and corrosion resisting chrome nickel coating on crown and seat, (b) has hollow head and stem, with chrome nickel coated crown and seat and hardenable steel alloy welded tip, (c) is a hollow head and stem design with no seat or head coatings, (d) has Stellite seat and hardenable steel welded tip. Hollow head and stem provide maximum cooling capacity in these valves. (Thompson Products photo)

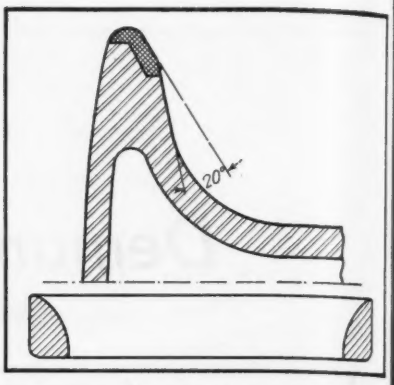


Fig. 4. Wright Cyclone inlet valve curved seat insert which reduces eddies and gives better gas flow.

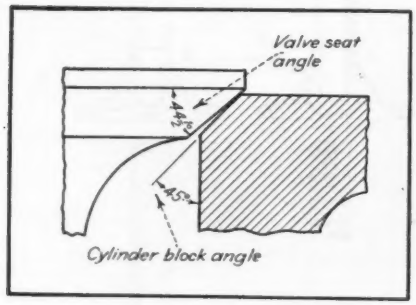


Fig. 5. Interference angle to insure seating at outer edge of valve, for purpose of preventing "gutter" on face through creeping of lead oxide deposits.

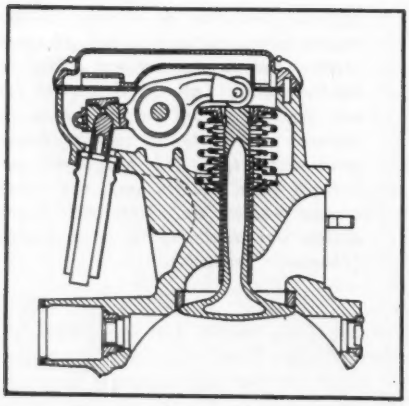


Fig. 6. Modern type rocker box with pressure lubrication which reduces wear.

and steel valve seat inserts, while we, in America, developed sodium cooling, the hollow valve head, and forced lubrication to reduce wear on the valve and rocker (Fig. 6).

Much valve breakage and excessive seat wear are caused by too great tappet clearance. This is graphically shown in Fig. 7, where two curves depict the difference in seating impact between normal and .010 excess clearance. Correct clearance is given on the engine plate, usually prominent on crankcase or housing.

Thick, rigid valve retainer locks formerly caused much valve stem trouble because they would not yield when stressed, but galled the stem at points where pressure was highest. Use of thin bronze locks with a taper of about 15 deg. has abolished this trouble.

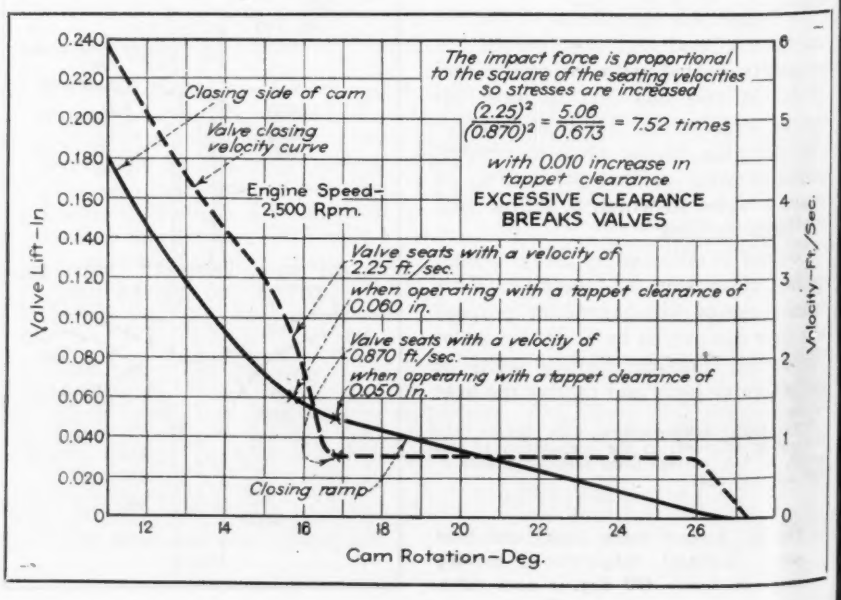


Fig. 7. Effect of incorrect tappet clearance. Impact varies as impact velocity squared giving 7.52 times greater stress if tappet clearance is increased .010. Excessive clearance frequently breaks valves.

When valves are first removed from the cylinder, they should be checked with the gage (Fig. 9) which tells at a glance if a valve should be discarded, or if it is worth servicing.

At this time, seat should be checked for discoloration or accumulation of carbon, either of which indicates that seating is imperfect.

Valve stems must be inspected for cracks, scores, pitting, or build-up on the portion under the head.

Springs require testing for strength and should be given a close inspection for cracks. Broken spring ends tend to cause the valve to spin, resulting in greatly increased wear.

Flat plug gages are used in conjunction with feelers to determine the wear, if any, of the guide bore. In the event that a guide is to be replaced for wear, breakage, or looseness, it should not be forced out but should be reamed until the thin remaining shell can be broken easily and the parts removed without harming the hole.

The hole is then cleaned out with the smallest reamer that will do the

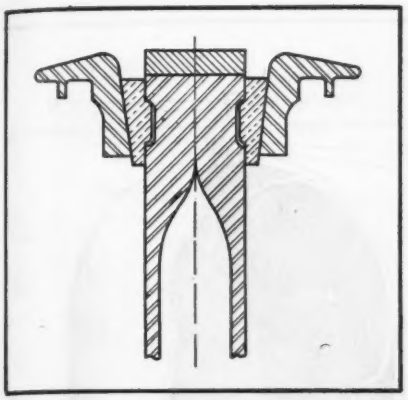


Fig. 8. Single-bead bronze retainer lock which tends to wrap itself around stem, obviating local galling often caused by thick, rigid locks.

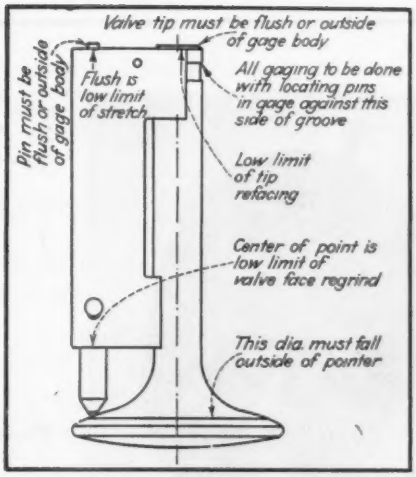

Valve tip must be flush or outside of gage body
Pin must be flush or outside of gage body
Flush is low limit of stretch
All gaging to be done with locating pins in gage against this side of groove
Low limit of tip refacing
Center of point is low limit of valve face regrind
This dia. must fall outside of pointer

Fig. 9. Exhaust valve limit gage for checking minimum refacing diameter, maximum removable material at tip, and stretch of stem.

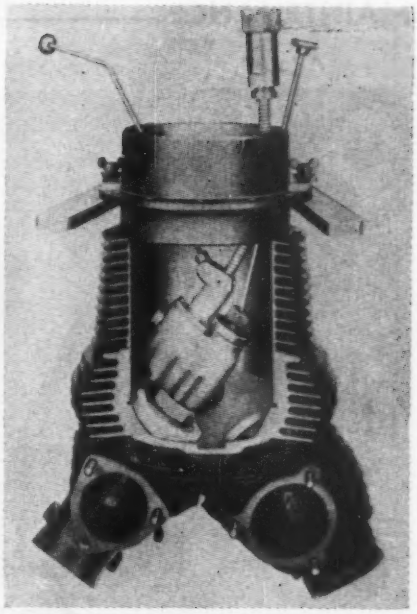


Fig. 10. Hall AW eccentric grinder used with flexible shaft for valve seat refacing.

work. Cylinder is heated at 600 deg. F. for an hour in an oven, while the guide is cooled in dry ice and denatured alcohol. After guide has been inserted for 15 to 20 sec., so that it is lightly gripped by the cooling cylinder, the installing arbor is tapped on the end to seat the guide. After cooling, the cylinder is air-pressure tested.

Seat inserts should be ground either with an eccentric grinder (as shown in Fig. 10) or a concentric grinder with vibrating drive (Fig. 11) which lifts the stone from the face during part of each revolution. Angle of seat should be as in Fig. 5, where there is an interference angle to insure valve seating at outer edge. Many valves are ground to 29 deg. 15 min. (plus 15 min. minus 0) to fit a 30 deg. seat insert. Valve and seat should be lapped in lightly, but only until the contact between them is continuous. This lapped surface should not exceed $\frac{1}{64}$ in. width.

Valves are reground in a special grinding machine (Fig. 12) which is sometimes fitted with water attachment for wet grinding. When valves are reground they may have a rough, sharp edge around the outside diameter of the face. This should be hand stoned down to a minimum radius of .010.

Glazed working surfaces of valve stems should not be removed or broken unless necessary, and the polished surface should be left with no scratches upon it.

After assembly into the cylinder, valves and seats are tested for tightness by closing all apertures, including lower end of cylinder, and by applying about 15 psi. air pressure. Then by pouring gasoline above the valves, any leakage or poor seating will be indicated by a stream of bubbles.

If it is realized that aircraft engine valves often seat 300,000,000 times during their effective life, the mechanic will have no difficulty in understanding that the greatest care is necessary when inspecting and servicing these small but highly stressed parts.

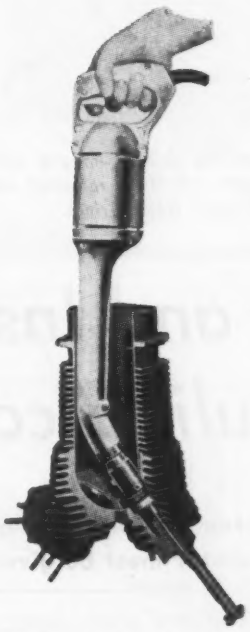


Fig. 11. Angle electric drive for vibrating valve seat grinder. (Black & Decker)

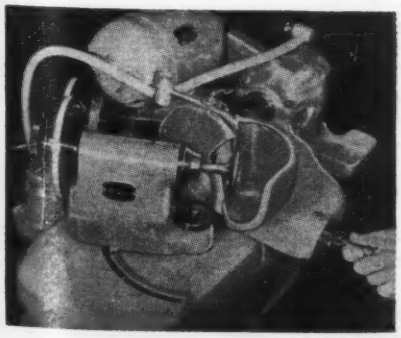


Fig. 12. Valve grinding machine which may be set to grind seats at any angle. (Black & Decker)

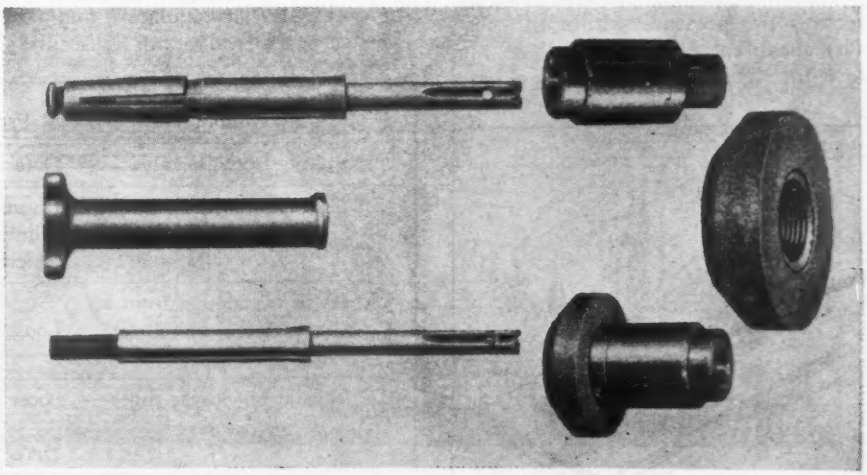
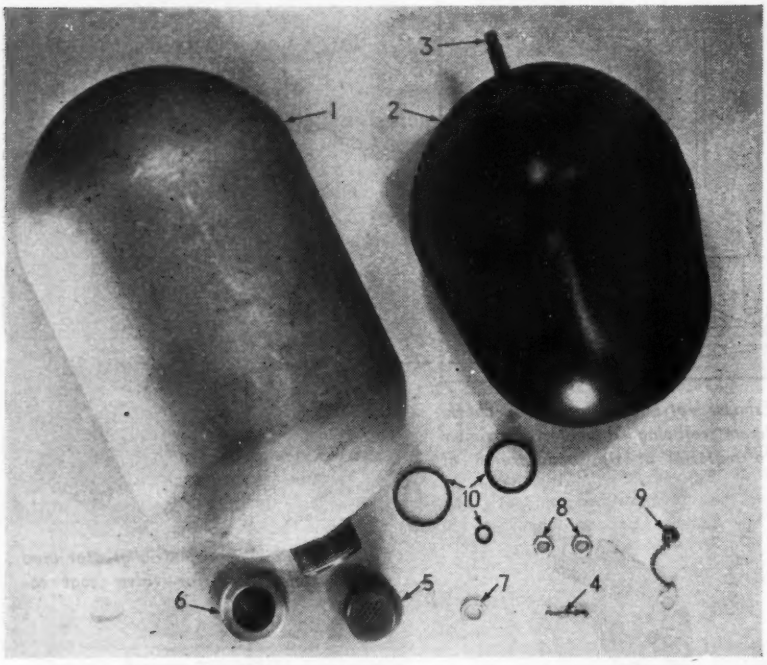


Fig. 13. Accessories used with grinder shown in Fig. 11. Self-centering pilot (top left). Plug pilot (bottom left). Pilot wrench (left center). On right are valve seat stone and ball-bearing sleeve, shown combined in third photo. (Black & Decker)



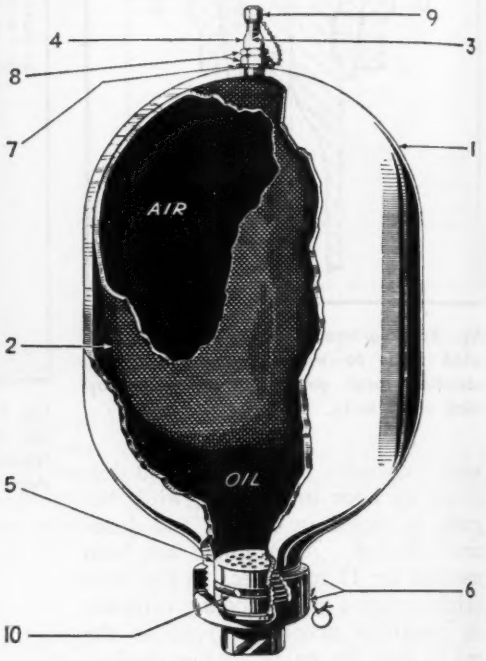


Fig. 1. Cutaway view of Simmonds accumulator, illustrating principles of operation, together with exploded view of parts. (1) Is steel shell, (2) synthetic rubber bag, (3) valve, (4) valve stem integral with bag, (5) oil discharge plug, (6) closure cap, (7) valve retaining washer, (8) nuts, (9) valve cap, and (10) rubber packing rings.

Service and Inspection Of Hydraulic Accumulators

Only standby for quick action when engine pump fails, hydraulic accumulator must be given care which high pressures demand.

SERVICE INSPECTION of the hydraulic accumulator consists of a visual checkup after installation. Here is the key routine: (a) See that proper air pressure, as indicated by manufacturer, is present in the bag, and preload as slowly as is convenient, to prevent temperature changes from affecting the pressure within the bag; (b) check valve core for leakage, and look for signs of oil at valve stem base, since oil at this point would indicate leakage; (c) observe whether there are any signs of leakage at oil discharge plug and adapter oil line fitting at base of accumulator; and (d) make sure that valve cap is securely down so that it will have no tendency to become loose in service.

Maintenance and lubrication are not required, except in the event of trouble. Table appearing below will be of assistance in remedying defects.

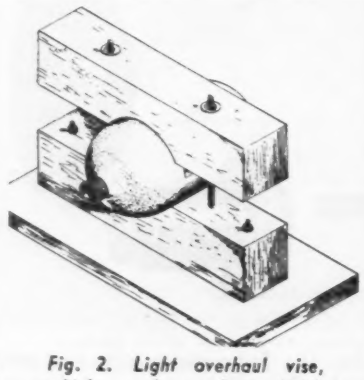


Fig. 2. Light overhaul vise, which can be made in field.

Trouble	Probable Cause	Remedy
Air leaking from air valve....	Defective valve core	Replace valve core
Air in lines after discharging..	Improper bleeding of oil lines upon installation	Bleed lines
	Defective bag	Replace bag
Traces of oil coming from air valve stem.....	Loose lock nuts	Tighten lock nuts at base of air valve
Oil leaks at oil closure cap....	Loose adapter fitting	Tighten plug fitting.
	Defective gasket	Replace gasket
Failure to operate.....	No air in bag	Charge with air
	Defective bag	Replace bag

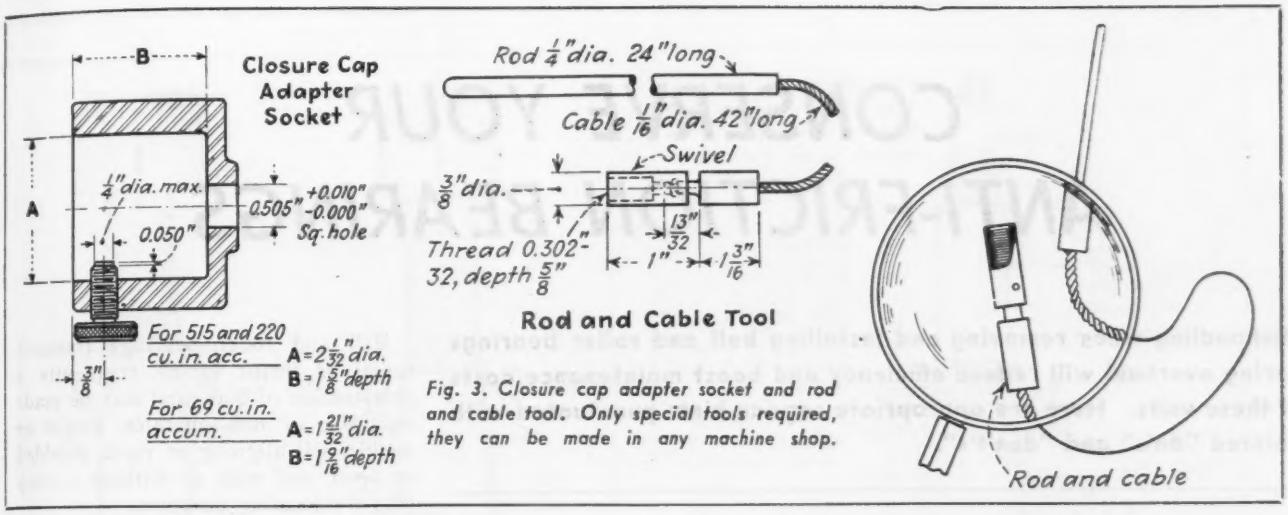


Fig. 3. Closure cap adapter socket and rod and cable tool. Only special tools required, they can be made in any machine shop.

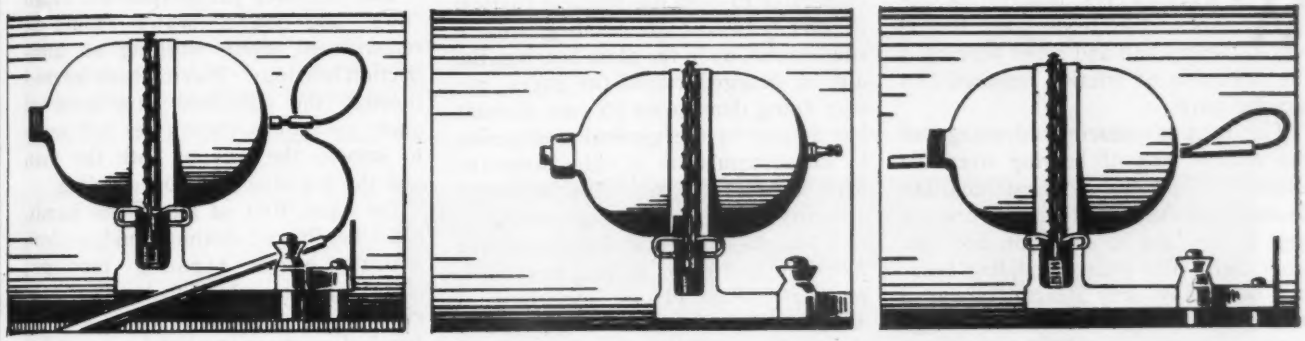
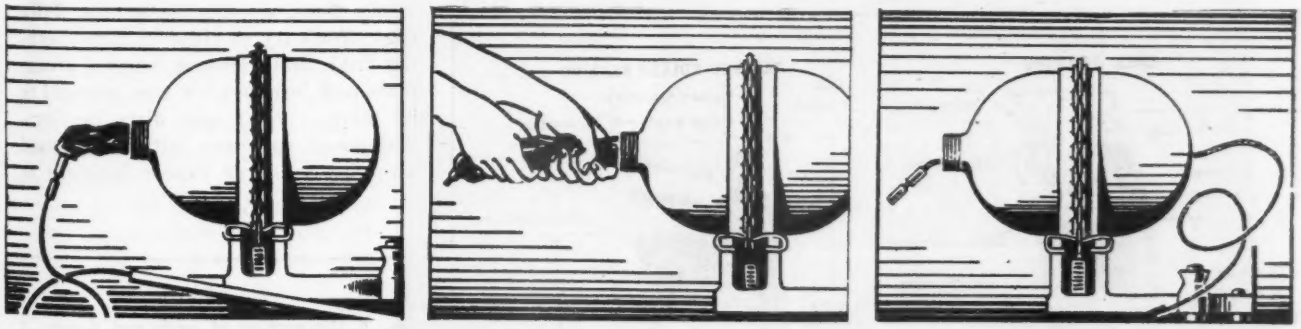
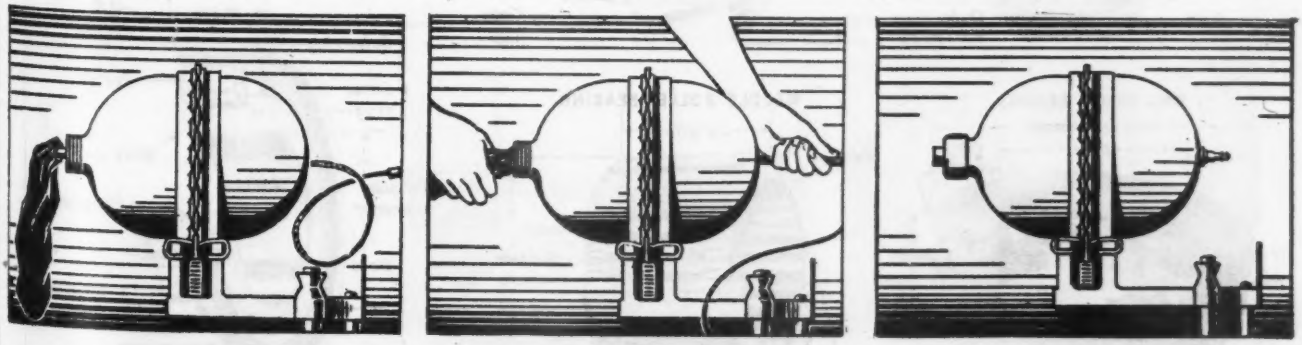


Fig. 4. Disassembly and assembly procedures. Left: Secure accumulator in vise and let out all air, removing valve, cap, nuts, and all parts. Center: Attach rod and cable tool to valve stem and press into shell. Remove oil closure cap, seal, and oil plug. If plug sticks, use short rod, threaded 3/4-16 as puller. Right: Push end of rod tool past bag until it projects as shown. Do not injure bag.



Left: Lubricate neck of shell with petroleum jelly and pull rod through until bag projects enough to grasp with hand. Center: pull bag steadily. If it does not draw easily, rock up and down. If there is a slot in shell, keep bag away from it. Right: Reassembly: Have hands and parts, including shell, absolutely free from all dirt, because particles inside shell at high pressure cause bag failure. Lubricate inside neck with petroleum jelly, insert swivel tool and remove valve core from bag after placing one gasket on valve stem.



Left: Squeeze all possible air from bag, attach swivel, start to draw bag into shell. Center: Pulling on tool, squeeze bag tightly with other hand and gradually push into shell. Be careful not to damage bag. Right: After valve stem is extended full length, install washer and nuts, centering stem before tightening nuts. Install valve core and cap. Place gasket in groove in plug, check for position of pin in side of plug (old models only) and replace plug in shell. Insert gasket in oil closure cap and screw tight. Put solder on seal hole.

CONSERVE YOUR ANTI-FRICTION BEARINGS

Mishandling when removing and installing ball and roller bearings during overhaul will reduce efficiency and boost maintenance costs of these units. Here are appropriate service hints punctuated with pointed "do's" and "don't's".

WHATEVER ITS INDIVIDUAL DESIGN, the basic idea behind every ball and roller bearing is the reduction of friction between two moving parts.

The friction-reducing advantage of the rolling type of bearing over the sliding design not only is nullified, but becomes a liability, if the parts are not kept in the best of condition and free from dirt. The plain or sliding bearing is usually only damaged over a small part of its surface when foreign matter is present or if the parts are assembled on a rough shaft, but rolling bearings—whether ball or roller—are vulnerable to even the smallest particle of dirt. Instead of bedding into a single point, as in the plain bearing, the dirt is dragged round the races, not only doing damage on its own account but adding to the general destruction by an accumulation of chips from the parts themselves, each chip becoming a means of producing many others.

When the structural features of the five principal types of ball and roller bearings (Fig. 1) are examined, it will be clearly seen why cleanliness is absolutely essential, considering the presence of so many small closely-fitting parts.

Ball and roller bearings transmit radial or thrust forces, frequently a combination of both, and may be made separable or non-separable, single or double, self aligning or rigid, shielded or open, and with or without a snap ring for locating purposes.

The following paragraphs will detail "do's" and don't's" which should be remembered while working on anti-friction bearings. Having been learned through the combined experience of many mechanics, these rules will serve to smooth the way of both the man and the machine he is overhauling.

Do have, first of all: *Clean* hands, tools, bench, and cleaning fluid; a *clean* housing before exposing bearings; *clean* paper on which to lay bearings; *clean* oil-proof paper in which to wrap finished work; *clean* lint-free rags for wiping; and the original container or one like it, for storage purpose.

Then, *don't* use dirty, chipped, or brittle tools, wooden mallets, or fluffy rags; *don't* try to rinse in dirty cleaning fluid; *don't* remove original grease from new bearings (it was intended to be there); *don't* spin dirty bearings, and *never* spin any with compressed air; finally, *never* expose bearings to

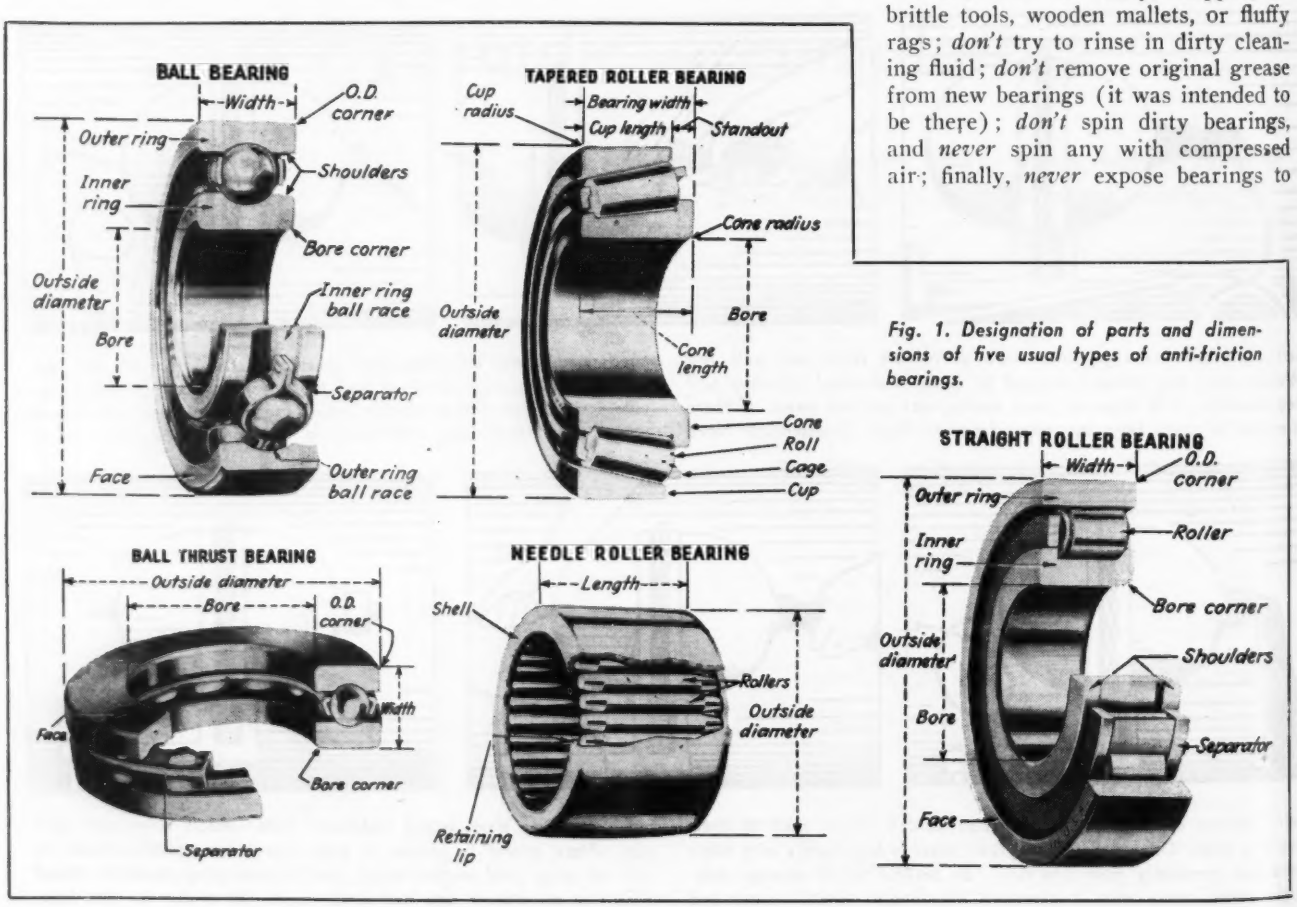


Fig. 1. Designation of parts and dimensions of five usual types of anti-friction bearings.

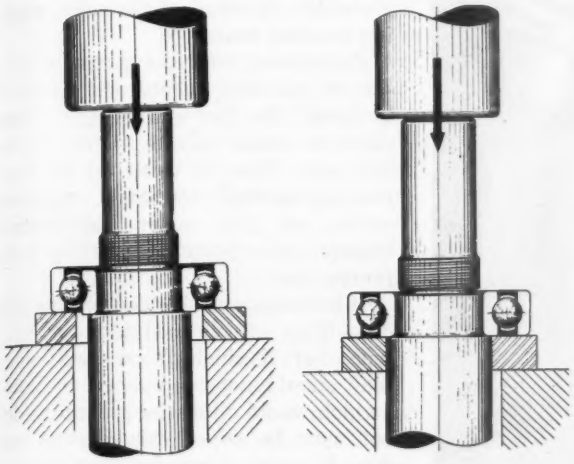


Fig. 2. Left: Wrong method of removing bearing (blocks contact outer ring and stress is through balls). Right: Correct method (blocks support inner ring and balls carry no pressure).

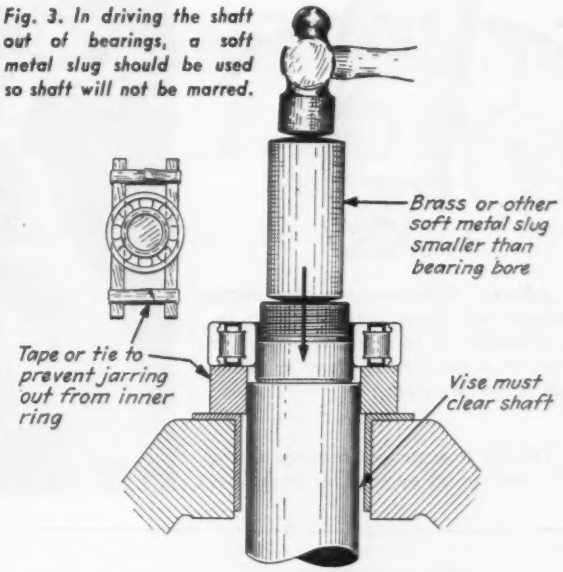

Brass or other soft metal slug smaller than bearing bore
Tape or tie to prevent jarring out from inner ring
Vise must clear shaft

Fig. 3. In driving the shaft out of bearings, a soft metal slug should be used so shaft will not be marred.

moisture or handle with moist or dirty hands.

When an installation is taken apart, the entire bearing usually remains in one part, being made a press-fit under ordinary conditions. If the bearing is separable, however, it is probable that each ring will stay in the part to which it was fitted.

In removing a bearing, always apply pressure on that part which is tight, and never use the balls or rollers to transmit the push or pull (see Fig 3). Hammers should not be used except where a soft metal slug or a block of hardwood is interposed between the bearing and tool.

When either removing or replacing a bearing, if pullers are used (Fig. 4) they should be carefully set so that they pull or push squarely (see Fig. 5), otherwise both shaft and bearing may be damaged.

In case a separable inner ring is installed against a shoulder of the same diameter, so that it is impossible to get hold of it with a puller, the ring must be partly cut with a torch if it is not usable, then struck sharply (as indicated in Fig. 6). It will then crack and can be removed easily. If, however, the ring is in good condition, it may be left in place and cleaned on the shaft.

Once removed, the bearing must be cleaned carefully. Attempting to judge

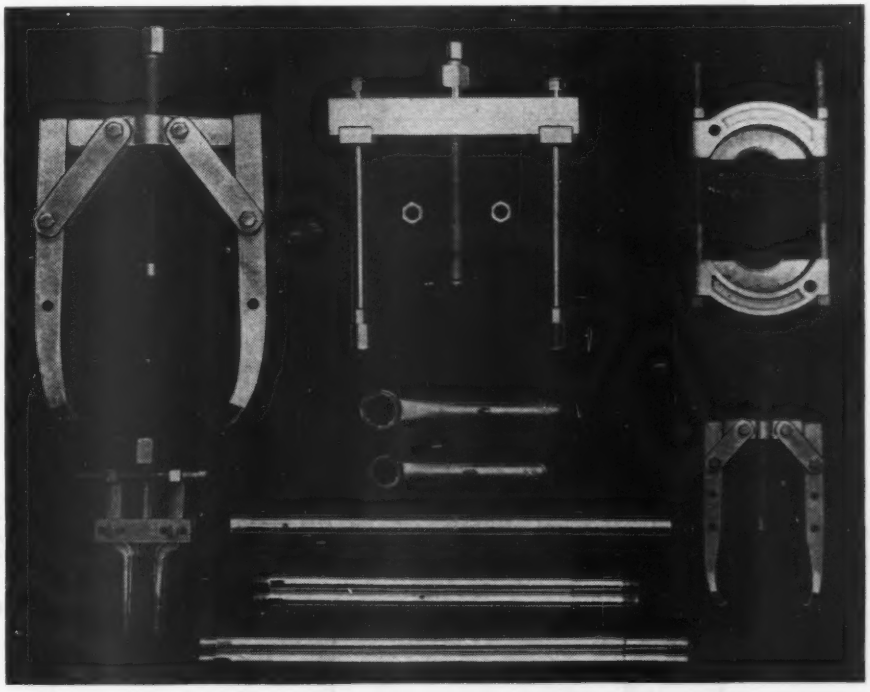


Fig. 4. Bearing pullers. They may be used singly or in combination to push or pull bearings on or off shafts.

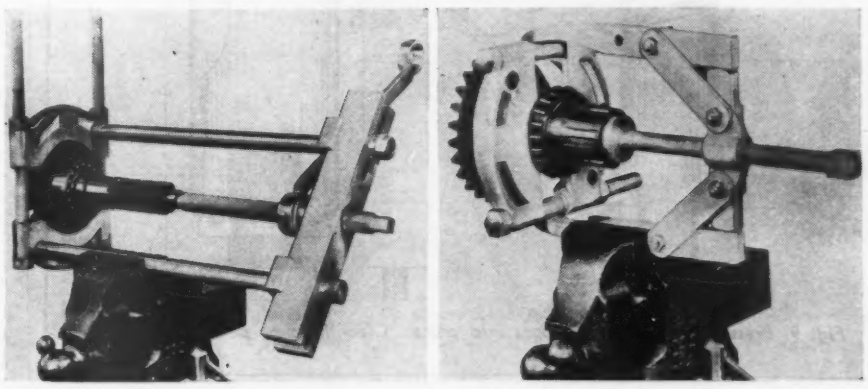


Fig. 5. Two arrangements of pullers to remove tight inner rings. When there is space behind bearing, puller should be adjusted so that it cannot slip over ring and thus damage surface.

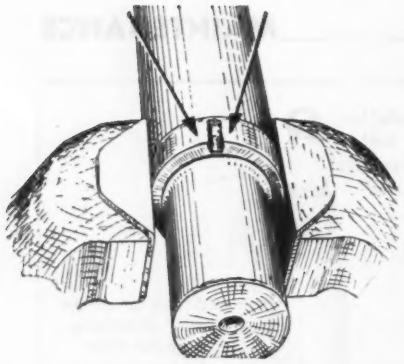


Fig. 6. (Above) When ring has been partly cut through with torch preparatory to removal, procedure is to strike it sharply (in direction of arrows) to fracture it, taking care not to damage shaft.

Fig. 7. (Right) How cleaned bearings should be held when turning by hand for inspection.

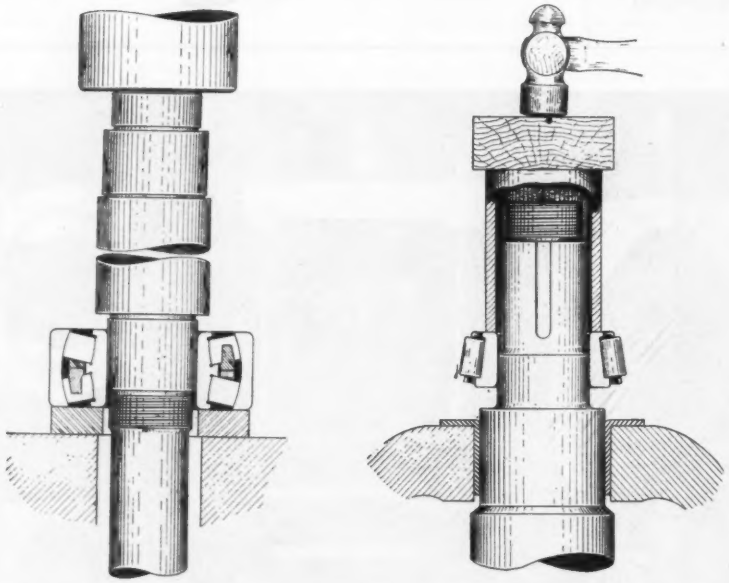


Fig. 8. In remounting bearings, care should be taken that blocks clear shaft (left), and hardwood block should be employed (right) when hammering tube.

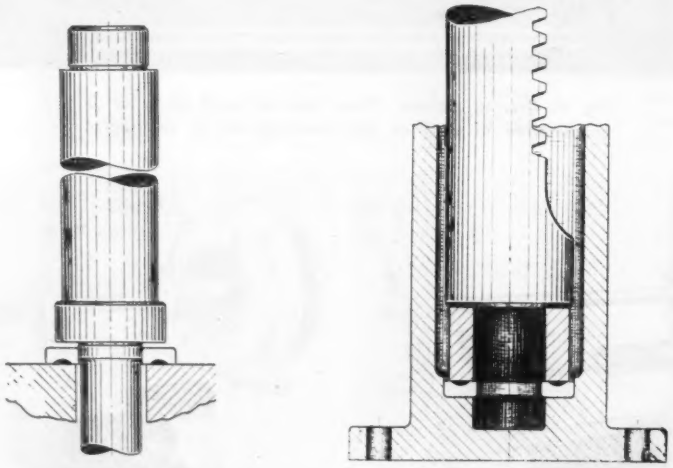


Fig. 9. Pressing thrust-bearing races into place. Cleanliness of parts is primary.

the condition of a bearing before cleaning is futile. Indeed, dirt may well mislead the mechanic into thinking that the bearing is defective, when all it probably requires is a thorough washing in clean fluid.

Procedure: Soak the parts in clean solvent, allowing plenty of time for it to loosen the dirt and grease. Then rinse in clean solvent, light oil, or kerosene. Dry by using an air hose, rotating carefully by hand. As stated earlier, do not, under any circumstances, spin bearing by using compressed air.

If bearings are shielded on one side only, they are cleaned like the open type, but if shielded on both sides, they should not be washed in liquid (which would dilute the grease inside) but must be wiped carefully to keep dirt from working inside and then coated with protective lubricant. If not to be used immediately, bearings should be lubricated and wrapped in oil-resisting paper, afterwards boxed for storage.

Shielded bearings which stick are to be sent back to the factory for checking, unless a plant for handling this special work is available.

When washing bearings, place in a wire basket and allow to soak for several hours, or until the grease has been dissolved. Rinse by sloshing 'round near the top of liquid, then allow to drain, and rinse in clean liquid. Inspect for freedom of movement (Fig. 7) and dip in rust preventive, unless the bearing is going to be used at once.

Inspection consists mainly of rotating the bearing by hand and observing

(*Turn to page 246*)

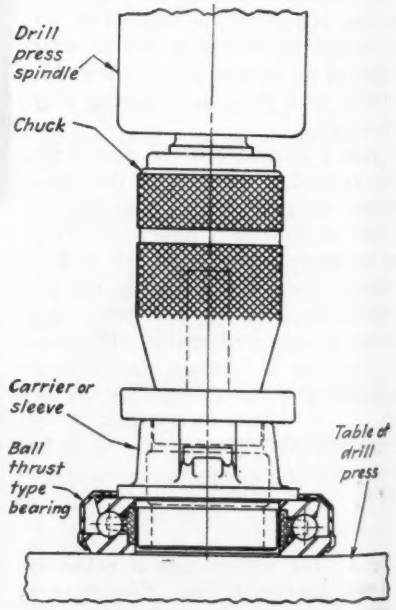


Fig. 10. Method of pressing banded thrust bearing into place by means of a drill press.

TIPS ON INSTALLING FLEXIBLE HOSE

By R. A. LIVINGSTON, *President, Tubing Seal-Cap, Inc.*

Detailing factors, precautions, and methods to assure maximum flexible-tube service and freedom from operational troubles.

SOLID TUBING will, of course, "fill the bill" when used in the various fixed components of an airplane. But in those units which move during operations—landing gear, wing flaps, and the like—such tubing would soon break under the stresses, hence flexible hose must be employed in these installations.

Flexible hose has a hollow synthetic rubber center, covered alternately with layers of wire or cotton braid and synthetic rubber (see Fig. 1). Both the numbers of layers and the material used, whether cotton or wire braid, will determine under what maximum pressure the hose will operate safely.

Fittings installed on the hose are swaged or compressed tightly to form a leak-proof connection. There is also a small hole drilled at the upper end of the swage, to allow any seepage to drain out. Since in many cases the inner sleeve of the hose extends slightly beyond the outer part of the fitting, hydraulic actuating cylinders should never be handled or hung loosely by their hose.

Furthermore, flexible hose must never be bent to a radius of less than six times its diameter. For maximum safety, nine times its diameter is a practical limit.

On all such hose, a stripe runs the entire length to indicate twist or torsion. This line should always be straight after installation, for if it is not, the hose will be under torsion, hence when under pressure it will tend to straighten out, and thus may shear off in the fitting or loosen the holding nuts.

A hose should never be stretched tightly between two fittings. About 5 to 8 percent of its total length must be allowed as slack, for it must be free for operation under pressure, when it shrinks and might pull out at the connections.

Small cuts and abrasions on the outer cover are not causes for rejection. However, every precaution should be taken to prevent such damage. Grave dangers of hose failures are obvious, especially in a landing gear system.

When lines are installed, they are held in place by fairleads, clamps, and blocks (Fig. 2). These supports are placed at specific intervals to reduce line vibration, and they are tightened only enough to hold the lines firmly (Fig. 3). In turn, these supports are bolted or bonded to the ship, in order to prevent the accumulation of static electricity that might interfere with the ship's radio.

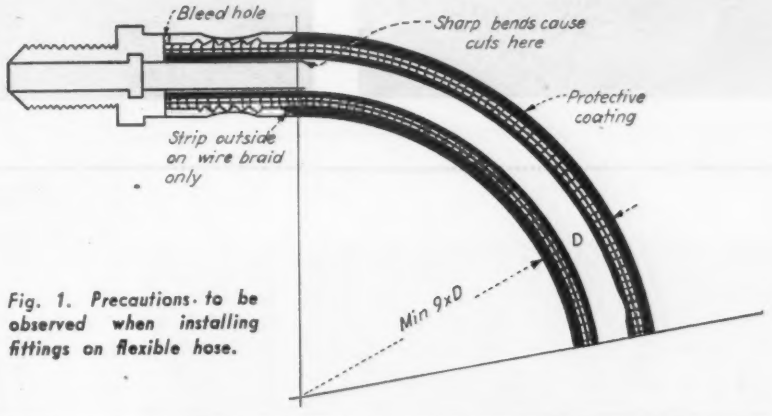


Fig. 1. Precautions to be observed when installing fittings on flexible hose.

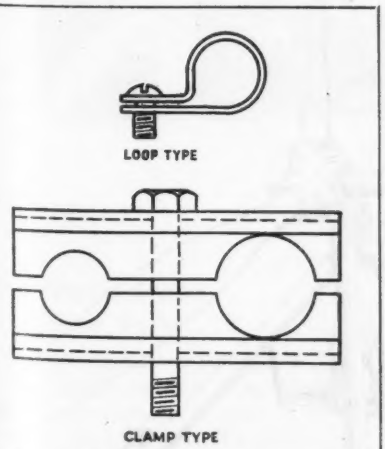
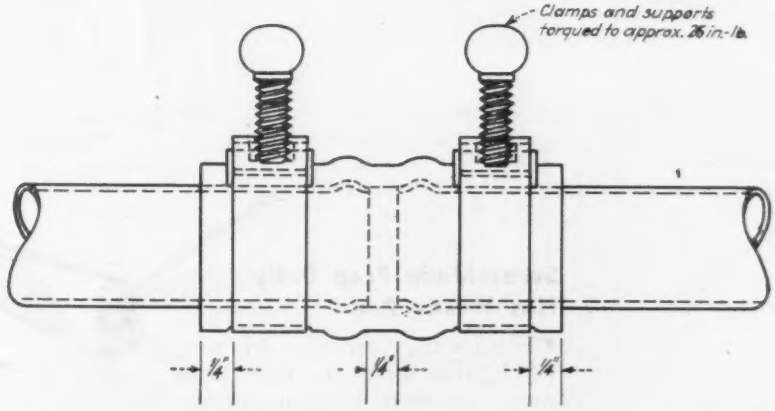


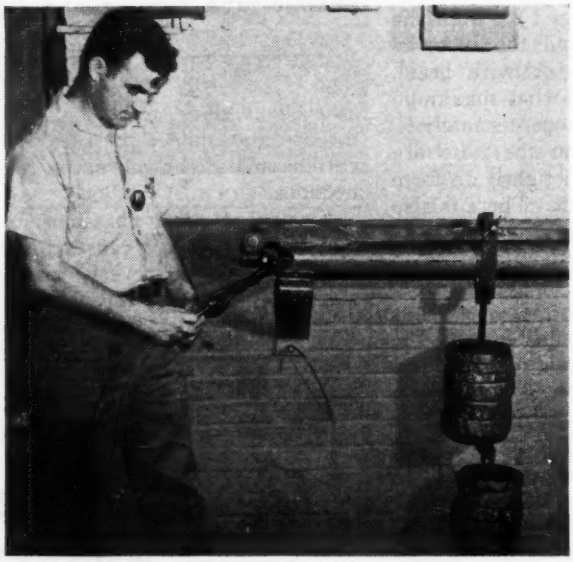
Fig. 2. Clamp and block used for holding hose in place when installation is completed.

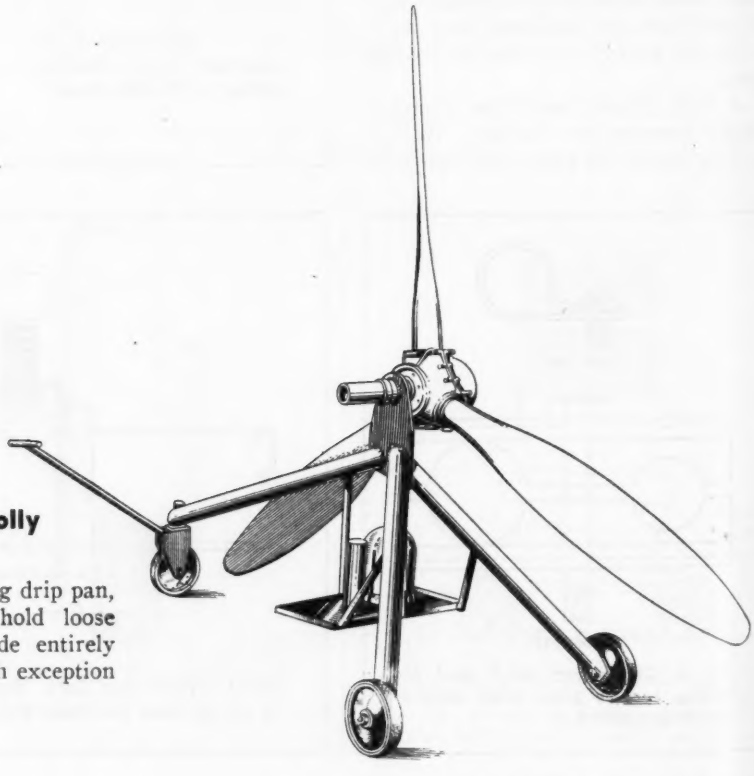


Fi9. 3. Typical hose joint. Gap clearance between ends should never be less than ¼ in. nor more than hose dia. Hose should project ¼ in. beyond fittings.

Cable Preloader Features Safety Pipe

• Using a 4-in. pipe to protect the operator, PCA built this cable preloader, fitting a weighted beam scale at one end and a screw for applying the load at the other. Foreman Tom Perry (left) and Asst. Foreman Ed Cunningham (below) are credited for development of this machine.



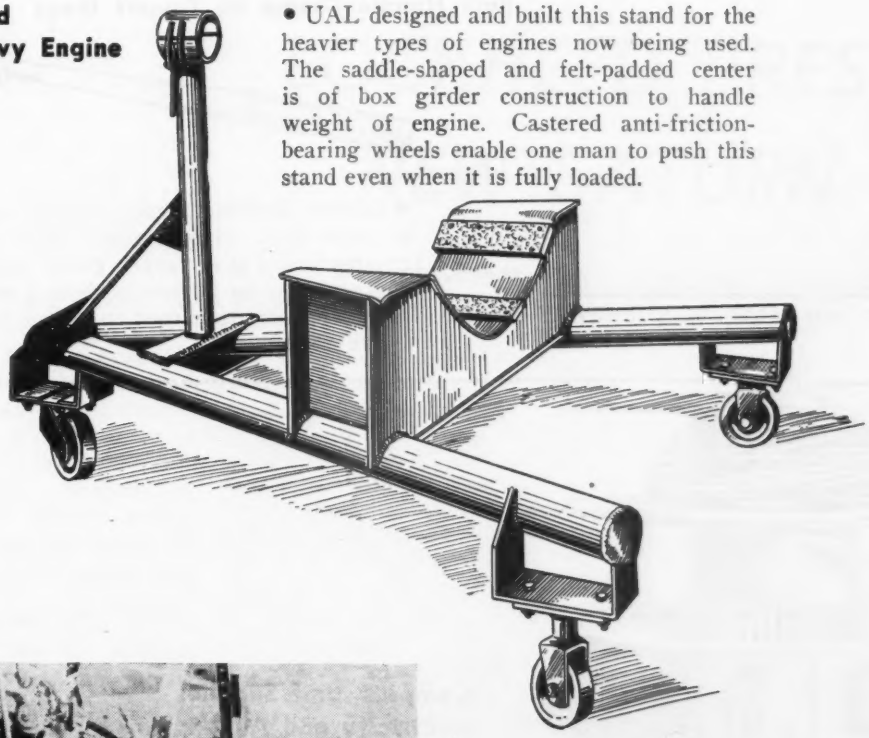


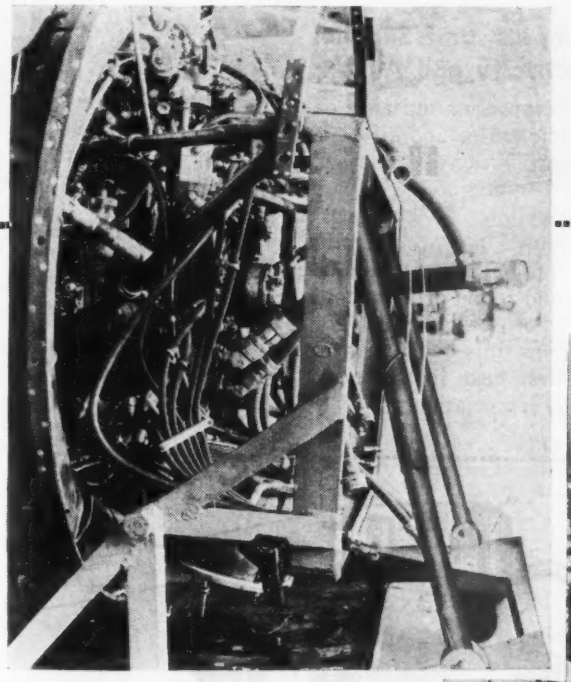
Scrap-Made Prop Dolly Has Handy Pan

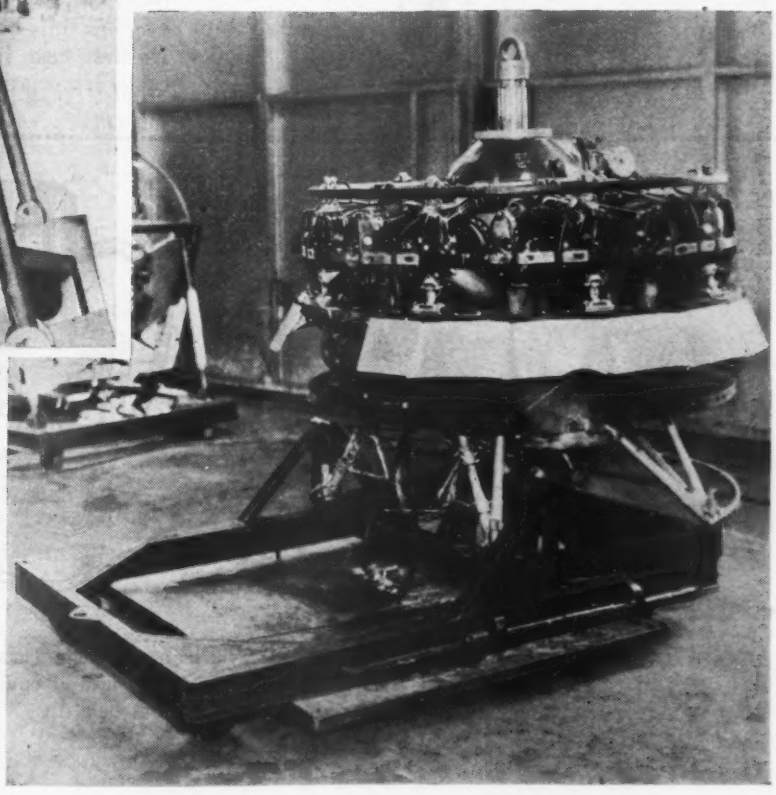
• Fitted with oil-retaining drip pan, which also serves to hold loose parts, this dolly is made entirely from scrap material, with exception of ball bearing wheels.

Light Stand Takes Heavy Engine

• UAL designed and built this stand for the heavier types of engines now being used. The saddle-shaped and felt-padded center is of box girder construction to handle weight of engine. Castered anti-friction-bearing wheels enable one man to push this stand even when it is fully loaded.





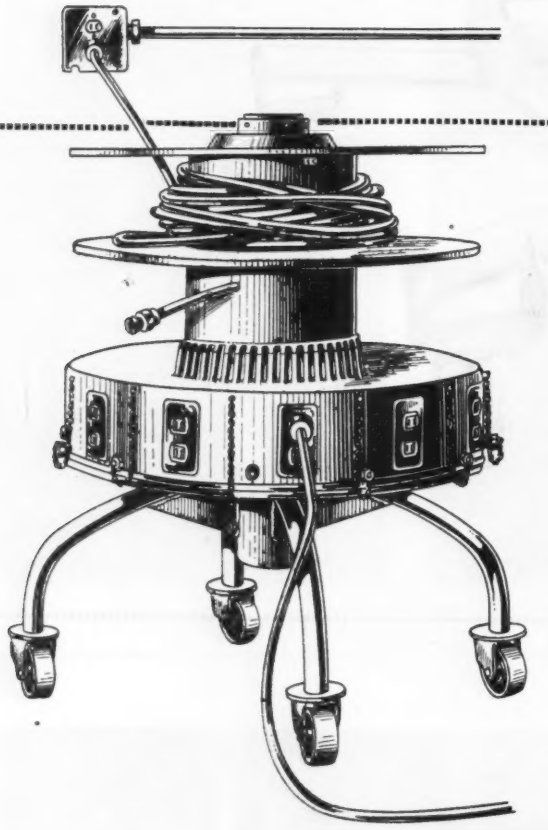


Tilting Engine Stand Proves Time Saver

• C & S use a double position stand for engine disassembly to gain time through greater working convenience. Engine is first lowered into place and worked on with shaft in a vertical position, then stand is tilted so that shaft is horizontal, thus permitting each phase of disassembly to be completed with least lost motion.

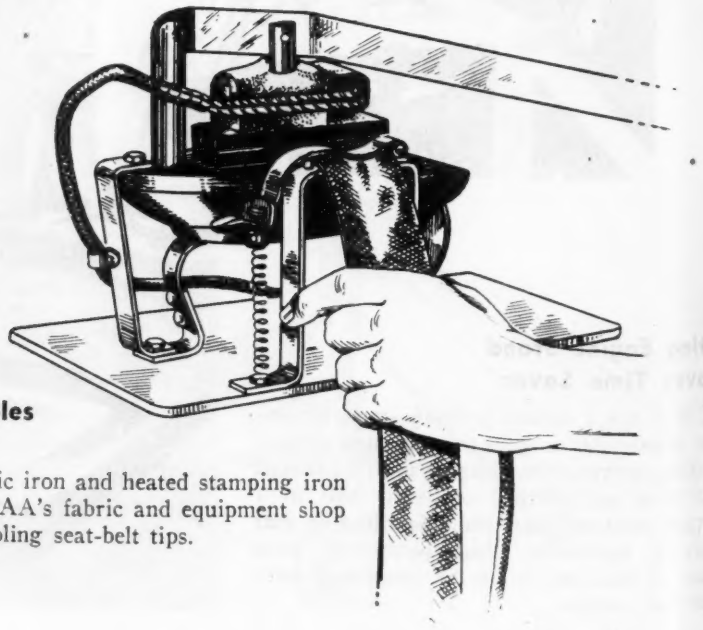
Puts Handle Clamp on Tappet Gage

• Edward Hedlund, senior aircraft engine mechanic at Ogden ASC, added a handle clamp, as shown here, to standard PWA tappet guide gage for R-1830 engines. Saving in time is about 5 min. per engine, and no fingers are burned on heated metal.



Compact Unit Supplies Electricity and Air

• To overcome nuisance of many long electric cables and air hose on hangar floors, Chicago & Southern uses this unit for compressed air and current distribution. Twenty electric and ten air outlets are provided, fed by single air hose (center) and electric line (wound round drum at top). Built entirely of scrap, except for plug connections, this device has already saved its first cost in decreased hose and cable depreciation.



Hot Iron Assembles Seat-Belt Tips

• An inverted electric iron and heated stamping iron were combined by PAA's fabric and equipment shop at Miami for assembling seat-belt tips.

LOCKHEED PRESENTS NEW SATURN 75

A fast 8-14 passenger feeder transport makes its bow featuring high degree of interchangeability of parts and utilizing wartime discoveries.

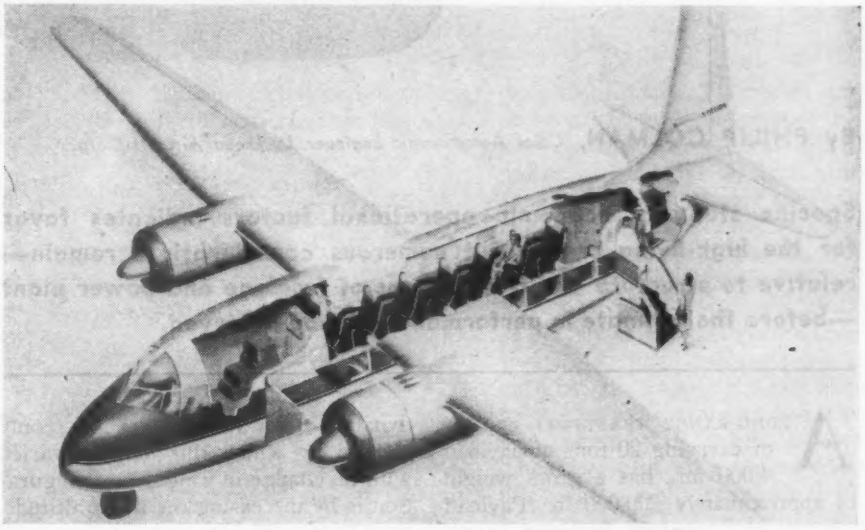
A COMPLETELY NEW DESIGN aimed at the postwar short-haul, high frequency airline transport market is Lockheed's Saturn 75. In announcing the new airliner, expected to be the successor to company's 1934 Electra, it was also revealed that two feeder-line operators have already ordered Saturns and that others are negotiating contracts.

Most noticeable feature about the Saturn is that the new airplane is a complete change from Lockheed's previous designs, as can be seen from accompanying sketches. The Saturn is a high-wing all-metal twin-engine monoplane, with single rudder and tricycle landing gear. Powered by two Continental-built 525-hp. Wright nine-cylinder radial engines and carrying 8–14 passengers with baggage and cargo, the Saturn has a top speed of 240 mph., cruises at over 200. Service ceiling is 26,000 ft. and the airplane will keep flying at 14,200 ft. on one engine. The eight passenger model has a maximum range of 1,600 mi. These figures are based on a gross weight of 13,500 lb. The Saturn's useful load factor is 50 percent.

The new Lockheed obviously incorporates many ideas evolving from wartime experience in servicing military airplanes under all kinds of conditions. Interchangeability of many parts, including the main landing gears' dual wheels, horizontal and vertical tail surfaces, elevators and rudders, stabilizers and fins show thought given to economy of operation and ease of maintenance. Passenger seats can be removed and a movable bulkhead allows quick conversion to cargo work. Complete engine units can be dismounted and replaced in ten minutes.

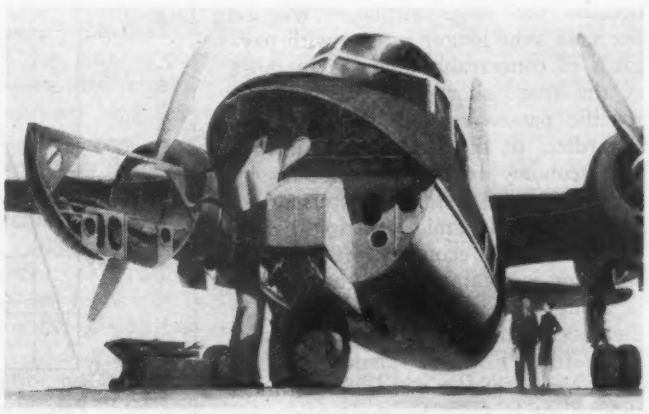
Specifications and data:

Passenger capacity	8-14
Crew	2
Normal gross wt.	13,500 lb.
Load factor	50 percent
Top speed	240 mph.
Cruising speed	over 200 mph.
Landing speed	73 mph.
Rate of climb	1,230 fpm.
Service ceiling	26,000 ft.
Single engine service ceiling	14,200 ft.
Maximum range	1,600 mi. (8 pass.)
Takeoff distance	1,055 ft.
Powerplant	2 Continental-Wright 9-cyl. 525 hp.
Propellers	Two-blade metal



Sketch of new Lockheed Saturn feeder airliner shows passenger seating arrangement and cargo space. Fuselage has movable bulkhead for all-cargo conversion.

High wing, single tail characterize Lockheed Saturn 75. Design assures good passenger visibility and easy cargo handling. Note main landing gear's dual wheels.



Ease of flight- and engine-instrument maintenance is shown, also details of nosewheel. Saturn's power plants can be changed in ten minutes.

HIGH VS. LOW AIR TRANSPORT

PART I

By **PHILIP COLMAN,** *Chief Aerodynamic Engineer, Lockheed Aircraft Corp.*

Specific study of economic operational factors indicates favor for the high-flying craft. But numerous considerations remain—relative to structure and installations of fuselage and power plant—before the ultimate in performance can be achieved.

A LONG-RANGE TRANSPORT capable of carrying 20 tons of payload 4,000 mi., has a gross weight of approximately 200,000 lb. Payload consists of passengers, baggage, cargo, mail, and express, items which require considerable space. Relative importance of speed and payload can best be shown by a comparison between two types.

Maximum aerodynamic efficiency is assumed for wing, fuselage, nacelle, and tail. Highest structural strength is also assumed to obtain minimum empty weight and greatest useful load. One pound of payload is equally important in a large airplane as in a small design, because the large airplanes will be operated over longer ranges with payloads of comparable amounts to those of the small short-range airplane. A specific passenger will weigh 180 lb. regardless of the size of the aircraft, and economy is reflected directly by the number of passengers transported.

Basic aerodynamic principles show that maximum economy of fuel consumption is obtained when the airplane is flying at a speed corresponding to the maximum ratio of wing lift to airplane drag. For an airplane of a given gross weight and at a specified altitude, this speed is fixed by the basic aerodynamic characteristic. The only method by which this may be varied with no change in weight or configuration is by increasing the flight altitude. Speed for maximum economy increases with altitude in the inverse ratio of the square root of the air density. This variation is illustrated in Fig. 1, which shows that an airplane flying at 25,000 ft. will obtain its maximum economy at a speed of 49 percent faster than the same airplane operating at sea level.

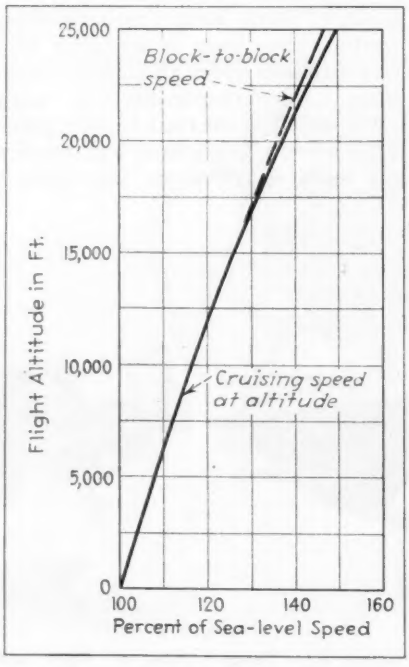


Fig. 1. Diagram showing effect of altitude on speed increase.

To demonstrate that the climb and descent times required are not a great detriment to the advantage of altitude, the times needed to complete a flight, as reflected in the average block-to-block speeds, are shown in Fig. 1 by the dotted line.

Assumptions for the calculation of block-to-block speed are: (1) The indicated speed for best economy is assumed to be 180 mph., true airspeed increasing with altitude as air density decreases; (2) ascent is assumed at an airline climb power of 75 percent m.e.t.o. power, giving a rate of climb of 600 fpm. at sea level, 400 fpm. at 25,000 ft., with forward speed in climb assumed to be that which obtains the maximum rate of climb, or 160 mph. as indicated; (3) descent is made at 750 fpm. at low cruising power, assuming a pressurized cabin so that rate of change of cabin pressure is not greater than 300 fpm. and that average forward speed is 270 mph.; (4) time for take-off plus landing is 13 min., and (5) a 4,000-mi. flight is used for this example.

Fig. 2 shows that the block-to-block speed is 47 percent faster at 25,000 ft. than at sea level, saving 32 percent of the time required at sea level.

Speed advantage of altitude is important, because, besides saving passenger time it also means more utilization of the airplane in terms of mileage flown. Less time in transit means greater regularity of schedules and reduced crew fatigue. Altitude operation has other advantages than those based solely on saving time, namely: (1) Improved meteorological condi-

* From paper presented at Los Angeles meeting of Institute of the Aeronautical Sciences.

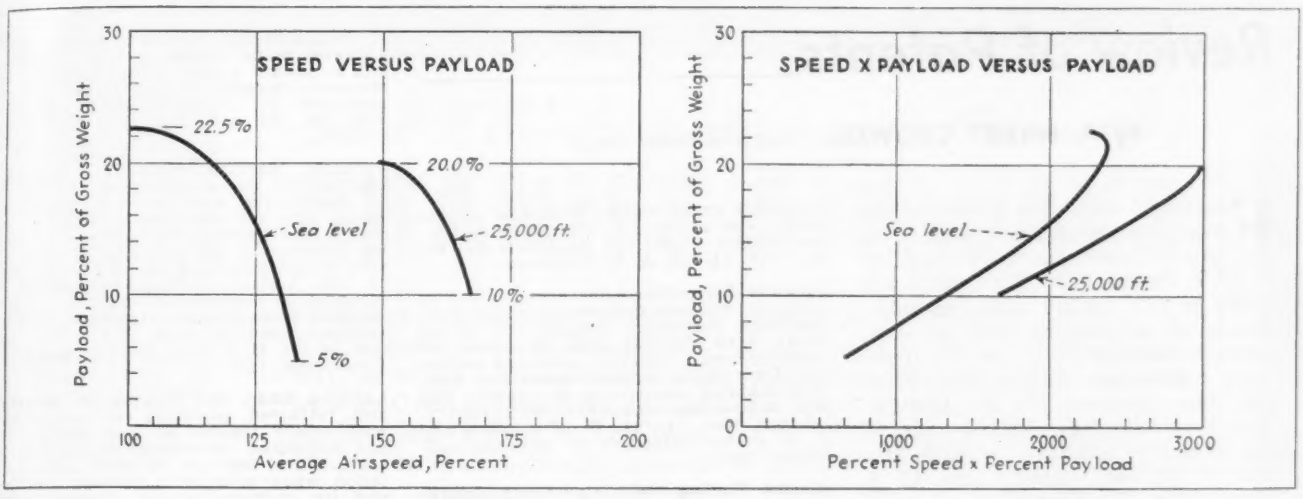


Fig. 2. Effect of altitude on speed for given payload (4,000-mi. range and takeoff weight of 200,000 lb.).

tions, such as freedom from storms or fogs and absence of icing conditions and of air turbulence; (2) regularity of schedules through improved weather conditions, requiring fewer flight cancellations and permitting better planning of flight schedules, resulting in better passenger service, reduced fuel reserve, and greater payloads, because of closer accuracy of flight planning; (3) more speed at altitude means less time lost through headwinds—for example, an airplane capable of cruising at 25,000 ft. may choose the most favorable altitude whereas a low-altitude airplane cannot, and (4) improved fuel consumption from reduced back pressure (to be discussed in a second article of this study).

Fig. 2 offers an example of payload capabilities of a transport cruising at 25,000 ft. compared to one designed for sea-level operation. Here, equal specific fuel consumption values are assumed (a breakdown of net fuel consumption will be discussed in the second article). To make this comparison, take-off gross weight of the various components for the sea-level airplane are:

Basic empty weight	=55.0 percent
Crew weight	= 1.2 percent
Airline equipment weight	= 1.5 percent
Payload plus fuel and oil	=57.7 percent

An airplane of 200,000 lb. gross weight is assumed for the 4,000 mi. range flight. Assuming flight weight of 180,000 lb., miles per gallon may be found from the following formula:

$$\frac{\text{mi.}}{\text{gal.}} = \frac{375\,(L/D)\,(\eta)\,(6)}{c\,(W_{av})}$$

where L/D = maximum lift-drag ratio
η = average propulsive efficiency
c = average specific fuel consumption
W_{av} = average flying weight

Study has shown that logical values for these factors are, $L/D = 23$, $\eta = 0.87$, $c = 0.40$ lb./bhp.

$$\frac{\text{mi.}}{\text{gal.}} = \frac{375\,(23)\,(.87)\,(6)}{.40\,(180{,}000)} = 0.625$$

Fuel required:

$$\text{For 4,000 mi.} = \frac{4{,}000}{0.625} = 6{,}400 \text{ gal.}$$
$$= 38400 \text{ lb.}$$
$$= 19.2 \text{ percent of gross weight}$$

Oil required is assumed in the ratio of 1 gal. of oil to 40 gal. of gasoline:

$$\text{Oil required} = 150 \text{ gal.} = 1{,}200 \text{ lb.}$$
$$= 0.6 \text{ percent of gross wt.}$$

Thus for the sea-level airplane, the total weight less payload = 77.5 percent of gross weight. The payload = 22.5 percent of gross weight.

The transport designed to fly at 25,000 ft. requires installations not necessary in the sea-level version. These items are: (1) Cabin supercharging provisions, including additional structure, ducting, and sealing = 0.3 percent of gross weight; (2) engine accessories, including engine and cabin superchargers, intercoolers, and controls = 1.4 percent of gross weight; and (3) nacelle structure for additional installations = 0.8 percent of gross weight.

Values obtained from design studies result in an empty weight for 25,000 ft. that is 2.5 percent greater than for sea level. This means that payload is reduced 2.5 percent or equal to 20.0 percent as compared to 22.5 percent of gross weight for the low-altitude airplane.

Fuel consumption has been calculated for maximum economy flight speed, 49 percent faster at 25,000 ft. than at sea level. Fig. 2 shows a typical variation of payload with speed for the two types of airplanes. Maximum economy points are on left-hand ends of the payload-airspeed power curve. Since this power is the same for both altitudes, speed variation follows the approximate rule for high cruising power that airspeed increases 1 percent for each 1,000 ft. of altitude.

Thus the 25,000-ft. airplane travels 25 percent faster than the sea-level version at maximum cruising power, or 16 percent of sea-level best-economy speed. For these constant power points, fuel consumption in gph. is constant. Thus fuel plus oil required for 4,000 mi. varies directly as speed. If fuel for sea level is 37.3 percent gross wt., fuel for high altitude is (133/167) (37.3) = 29.8 percent, a difference of 7.5 percent.

Therefore, if the sea-level airplane has 5 percent payload at maximum cruising speed, the 25,000 ft. airplane has $5 + 7.5 - 2.5 = 10$ percent payload for 4,000 mi. at maximum cruising speed.

Real test is the amount of payload transported per year. Assuming that both aircraft have equal utility and equal flying hours per year, the airplane that carries a given number of pounds the greatest number of miles at the same cost is the most valuable. Criterion is lb./mi./hr. (as in Fig. 2), multiplying percent-speed times percent-payload. The right-hand chart in the figure shows the result, with the 25,000-ft. airplane exceeding the sea-level type for all payloads. Maximum lb./mph. at 25,000 ft. is 25 percent greater than at sea level, in spite of 2.5 percent greater empty weight.

This establishes the choice of the high-altitude airplane for this study, and the remainder of the work entails choice of best design to obtain the ultimate in airline performance for a high-altitude long-range transport.

Review of Patents

By A. HARRY CROWELL, *Registered Patent Lawyer*

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any of patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

Improved Control and Stability through medium of lift modifications is purpose of wing design embodying leading edge cutout portions with associated closure means to vary effective area of individual notches.—2,358,985, filed Feb. 23, '40, pat. Sept. 26, '44, J. P. McAndrew.

Unit Construction of Flying Controls, to facilitate installation and pilot reach-adjustment, is characterized by rudder, elevator, and aileron controls being supported on longitudinal hollow member upon which pilot's seat and foot-rests are adjustably mounted. Control lever, pivotally connected to shaft in tube for fore-and-aft oscillation to actuate elevator, is oscillatable for sidewise manipulation for aileron control. Rudder bar also is oscillatably supported.—2,359,233, filed Oct. 27, '41, pat. Sept. 26, '44, J. Martin.

Ornithopteral Structure is provided in design to permit takeoff on level ground without need of hard or smooth runway. Incorporated is high-speed wing integral in construction and semicylindrical transversely. Ends of wing are substantially tangent to direction of motion of reacting air so that latter is deflected by wing through angle of 180 deg. and is moved downwardly instead of being deflected sidewise.—2,359,264, filed Feb. 11, '42, pat. Sept. 26, '44, I. Benjamins.

Radio Beam Device, intended for use where usual radio range beacons are not available, is installed in flight-training plane and provides artificial aural radio-range signal. Apparatus includes conventional audio frequency oscillator coupled to two amplifiers through radio range keying unit. Provision is made for varying volume and relative intensities of signals.—2,359,294, filed Feb. 18, '43, pat. Oct. 3, '44, C. Blenman, Jr.

Portable Deck Design for airplane runways eliminates spring clips for locking deck planks by providing integral locking lug.—2,359,548, filed Sept. 9, '43, pat. Oct. 3, '44, C. B. Cushwa, Jr., and G. G. Greulich, assignors to Carnegie-Illinois Steel Corp.

Remote Drive between engine and propeller is to permit location of latter at a distance from engine and aims to reduce vibration and backlash stated as inherent in such prior installations.—2,359,652, filed May 13, '41, pat. Oct. 3, '44, V. A. Larsen, assignor (mesne assignments) to Reconstruction Finance Corp.

Airplane Control Mechanism aims to eliminate rudder and conventional form of elevators by featuring lateral and vertical pockets projecting radially from tail portion at 90 deg. with each other. Opening of either lateral pocket is intended to steer plane to that side, and vertical pockets would be opened to control ascent or descent.—2,360,116, filed Mar. 31, '42, pat. Oct. 10, '44, E. J. Elias.

Propeller Blade Manufacturing Process is stated to achieve fast production by use of new metal compositions and new method of pouring and casting to avoid banding and carbide segregations. Permanent mold is provided with a cavity to form exterior of blade, a pouring-aperture extending along cavity, a series of collapsible gates leading from aperture to cavity, and a core for forming blade hollow interior.—2,362,745, filed Oct. 30, '41, pat. Nov. 14, '44, A. C. Davidson.

Compass-Correction Apparatus for use in magnetic compass compensation has non-magnetic turntable adapted to rotate about fixed vertical axis in center of compass rose, turntable permitting swinging of associated airplane about rose axis, thus enabling comparison of compass and rose indications.—2,362,629, filed June 7, '43, pat. Nov. 14, '44, W. H. Griffith and C. J. Colby, assignors to International-Stacey Corp.

Airport Fueling Mechanism contemplates expeditious fuel delivery to plane at a rate of about 150 gal. per min. in bottom fueling operation. Included is flexible collapsible hose fully extended only during fuel delivery, assuming flattened position with all fuel withdrawn before connection to plane fill-pipe is broken. Hose diameter is stated as twice that of ordinary wet hose, to permit delivery of more volume at lesser pressure.—2,363,559, filed Apr. 7, '44, pat. Nov. 14, '44, R. J. Jauch and F. W. Sturm, assignors to The Wayne Pump Co.

Airspeed Control and Spin-Delay Assembly, relating to improvements in instrument-flying trainers, provides mechanism to automatically prevent trainer from spinning when turbine is first turned on and to permit accurate indication for instrument takeoff so that latter may be practiced by students.—2,632,486, filed Feb. 29, '44 pat. Nov. 14, '44, S. A. Holbert.

Portable Service Unit is especially adapted for the illumination of airports, for facilitating starting of airplane engines, and for emergency welding. Included are lighting equipment, comprising searchlight and floodlights, and engine-driven generator-set to produce high or low voltage current. Apparatus is mounted on semi-trailer unit and is freely movable when disconnected from traction vehicle.—2,360,420, filed May 8, '43, pat. Oct. 17, '44, H. E. Hill, assignor to Lister-Blackstone, Inc.

Landing Gear, self locking in extended and retracted positions, is constructed with safety feature of dual wheels and has individual retracting mechanism for each. Wheel legs are in close-spaced relation when gear is in landing position, one leg carrying socket member while other carries plug member so that legs are held in proper upright position and cannot become offset.—2,360,759, filed Oct. 5, '42, pat. Oct. 17, '44, E. E. Chalbert.

Guiding and Releasing Device for airplane sliding canopy is intended to permit jettisoning by a single control, whether hood is or is not under pressure internally or regardless of position. Guide tracks for slide bar at each side of hood have inner fixed rail and outer hinged rail, latter being controlled by spring mechanism.—2,361,113, filed Apr. 17, '43, pat. Oct. 24, '44, M. J. O. Lobelle, assigner to Messrs. R. Malcolm, Ltd.

Book Reviews

AIRPORTS AND THE COURTS, by Charles S. Rhyne. National Institute of Municipal Law Officers, Washington, D. C., 222 pages.

A collection with analyses of reported court decisions involving acquisition, operation, maintenance, and zoning of airports, together with an analysis of federal, state, and local legislation in the airport field. The air-space rights of landowners and of airport operators are dealt with in the light of applicable legislation and legal principles.

NOTES ON HELICOPTER DESIGN THEORY, by Alexander A. Nikolsky. Princeton University Press. 228 pages, charts, graphs. $3.00.

Technical collation of mathematical, theoretical, and mechanical factors bearing upon helicopter design.

MECHANICAL SPRINGS, by A. M. Wahl. Penton Publishing Co., Cleveland, Ohio. 435 pages, charts, index. $6.00.

Based on original research, the volume treats of factors regarding springs, including results of investigations carried out under the direction of the American Society of Mechanical Engineers and the War Engineering Board Spring Committee of the Society of Automotive Engineers. Objectives of this book are better spring design through elimination of rule-of-thumb methods.

INSTRUMENT FLYING AND RADIO NAVIGATION, by Holland L. Redfield. Ronald Press Co., N. Y. C. 195 pages, charts, illustrations, index. $3.00.

A simple and systematic guide to instrument flying and related radio avigation as required for the handling of fast, modern aircraft. Profusely illustrated.

ENGINOLOGY. Published by Wright Aeronautical Corp. 63 pages, illustrated.

The life history of the internal combustion engine, particularly the airplane engine. Told in prose and pictures, this pamphlet graphically traces the development of the internal combustion engine from its beginnings up to the highly powered present-day Wright aircraft engines. Basic principles of operation are detailed, and there is included a chapter on flight theory.

INTERNATIONAL AIR TRANSPORT, by Brig.-Gen. Sir Osborne Mance and J. E. Wheeler. Oxford University Press, N. Y. C. 117 pages, map. $1.00.

Part of a series devoted to surveying the problems of international communications and transport. The study is highly detailed.

SANK SAME, by William B. Mellor, Jr. Howell, Soskin Pub. Inc. N. Y. C. 255 pages, photographs. $2.50.

Review of work by Civil Air Patrol and Coast Guard Auxiliary in helping detect and destroy Nazi submarines during the height of undersea onslaught against Allied shipping.

PRACTICAL MANUAL OF THE E-6B COMPUTER, by Allen C. Zweng and E. F. Degon. Pan American Navigation Service, Hollywood, Calif. 124 pages, graphs, problems, answers, appendix, index. $2.00.

A manual covering use of Dalton E-6B (Army Type) avigational computer. Problems include radius of action, off-course, interception, alternate airport.

DAMNED TO GLORY, by Col. Robert L. Scott, Jr. Scribner's, N. Y. C. 228 pages. $2.50.

Recount of highlight aerial exploits of war. Written by author of "God Is My Co-Pilot" book shifts its continuity from one war front to another. There is special emphasis on role played by Curtiss P-40.

FIRST OF THE MANY, by Capt. John R. (Tex) McCrary and David E. Scherman. Simon & Schuster, N. Y. C. 242 pages, photos. $3.75.

A journal of the activities in war of men of 8th Air Force who conducted first air raids over Germany. (Royalties are contributed to the Army Air Forces Aid Society.)

WINGED PEACE, by Air Marshal William A. Bishop, RCAF. Viking Press, N. Y. 175 pages, photos. $2.75.

An authoritative, searching viewpoint of aviation and its development in future, posing question of "winged peace or winged death". Says this famous Ace

(*Turn to page* 266)

The B.F. Goodrich Airline of the month

BRANIFF AIRWAYS

ONE OF THE FASTEST-GROWING United States airlines, Braniff Airways serves the central southwest from the Great Lakes and the Rockies to the Gulf. Traffic to and from Mexico, Central and South America moves through the Brownsville and Laredo gateways, cementing our nation's industrial, commercial and cultural relations with neighbors "south of the border."

Many B. F. Goodrich products fly with the busy DC-3's in the Braniff fleet. Silvertown tires help steady the take-offs and cushion the landings, and De-Icers add their important factor of safety in icing conditions.

The men and women of Braniff have done an outstanding job of building an important part of America's transportation. To them our salute . . . our nomination of Braniff Airways as this month's "Airline of the Month."

In war or peace

B.F. Goodrich

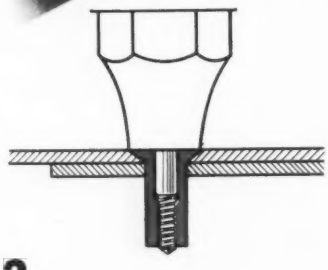
FIRST IN RUBBER

FROM THE GREAT LAKES AND THE ROCKIES TO THE GULF

Fasten *with* it... Fasten *to* it ...B. F. Goodrich RIVNUT *makes tough problems easy*

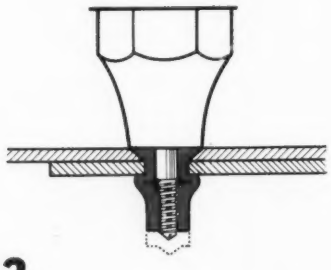
...Here are the ABCs of Rivnut Installation

1 Thread Rivnut onto pull-up stud of heading tool until head of Rivnut touches anvil.



2

Push Rivnut into hole with head firmly against, and at right angles to, the work.



3

A squeeze on the tool lever retracts pull-up stud slightly, causing a lateral bulge upset of the Rivnut.

4

Attaching accessory with screw is easy now. Rivnut threads grip screws firmly after upset.

SIMPLICITY KEYNOTES the B. F. Goodrich Rivnut. It is the *only one-piece* blind fastener that can be used as a blind rivet . . . as a nut plate for attachment . . . or both at once!

Rivnuts are tubular rivets with counterbored shanks internally screw-threaded. These fasteners are headed with an easily operated hand tool while working entirely from one side. When upset, a ring-type bulge forms on the blind side which is large enough to resist being pulled through the work even under conditions of eccentric load.

Rivnuts are light, strong, low-cost, ready for use as received. Installation is so easy, even blind men are doing it efficiently. Requiring only a very small hole, Rivnuts form a compression fit. And keyed Rivnuts are available where high torque-resistance is desired.

Aluminum, steel and brass Rivnuts are now being made; also an aluminum Rivnut with splined shank to use in wood. A broad range of standard types and sizes is available. And if some special Rivnuts are needed, B. F. Goodrich engineers will work out designs with you.

WRITE FOR FREE COPY OF "RIVNUT DATA"

Contains full facts on sizes, types, grip ranges, strengths, weights. Step-by-step illustrations. For your free copy, write now to The B. F. Goodrich Company, Dept. J1, Akron, Ohio.

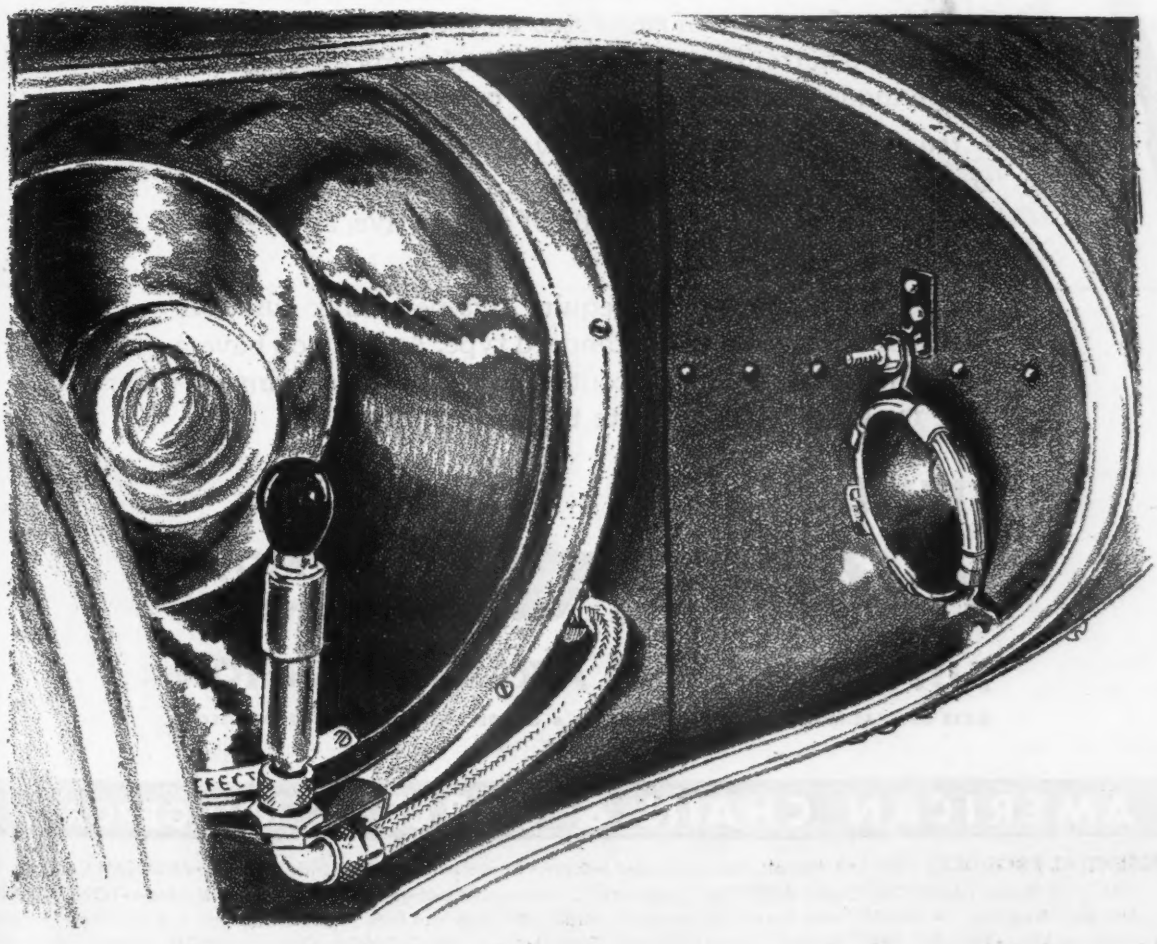
AVIATION'S *New Regular Feature*

FOR *Better Design*

MIRROR SPOTLIGHTS LANDING GEAR

FOR AN ADDITIONAL NIGHT-FLYING check on the landing gear position, wing light recesses of Penn-Central Capitoliners have recently been equipped with mirrors adjusted to reflect landing light rays to illuminate undercarriage when latter is in the extended position, thus providing pilot with visual proof that the gear is down.

Prior to use of the mirror installation, devised by PCA employee Richard Hamilton, illumination of landing gear by a wheel well light did not prove completely satisfactory.



THEY WERE *Good* . . .

BUT WE *Improved* THEM

TRU-LAY PUSH-PULL CONTROLS have always been good. We've been making them for years and always they have done their work well—usually outlasted the equipment on which they were used.

But nothing is ever too good to go into aircraft—especially Army and Navy aircraft. We found that, by improving the performance of **PUSH-PULLS**, we could make them do a certain job better than it could be done by any other means. So we made an improved **PUSH-PULL CONTROL.**

TRU-LAY PUSH-PULL CONTROLS are available today that are even smoother in operation—even more positive in action than those now serving in thousands of automotive, aircraft and industrial applications.

Your purpose may not require this new, finer **PUSH-PULL.** We continue to make the standard type. And, if you have a problem involving remote control, it will pay you to investigate **TRU-LAY PUSH-PULLS.** Write to the Detroit office.

TRU•LAY

PUSH-PULL REMOTE CONTROL

AUTOMOTIVE AND AIRCRAFT DIVISION

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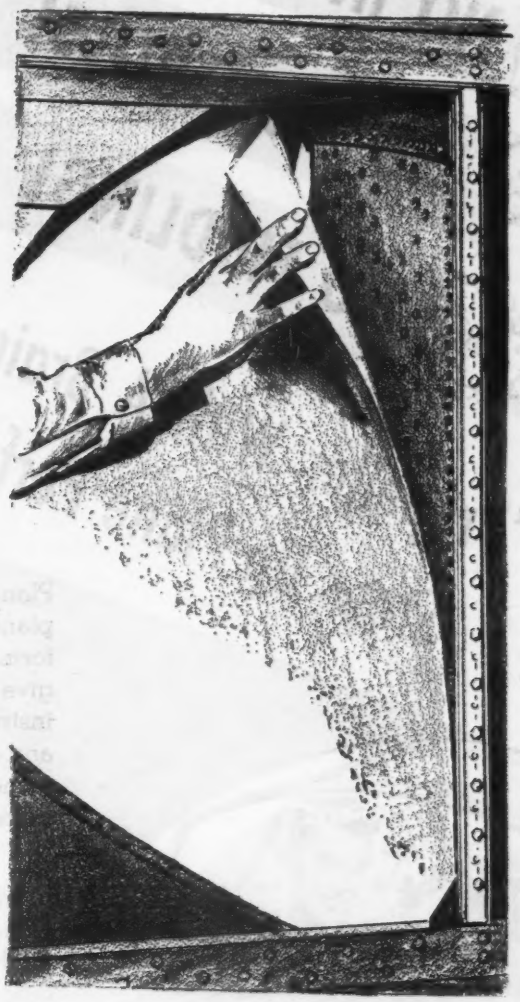
ESSENTIAL PRODUCTS • TRU-LAY Aircraft, Automotive, and Industrial Controls • TRU-LOC Aircraft Terminals • AMERICAN CABLE Wire Rope • TRU-STOP Brakes • AMERICAN Chain • WEED Tire Chains • ACCO Malleable Castings • CAMPBELL Cutting Machines • FORD Hoists, Trolleys • HAZARD Wire Rope • MANLEY Auto Service Equipment • MARYLAND Bolts and Nuts • OWEN Springs • PAGE Fence, Shaped Wire, Welding Wire • READING-PRATT & CADY Valves • READING Steel Castings • WRIGHT Hoists, Cranes • WILSON "Rockwell" Hardness Testers

In Business for Your Safety



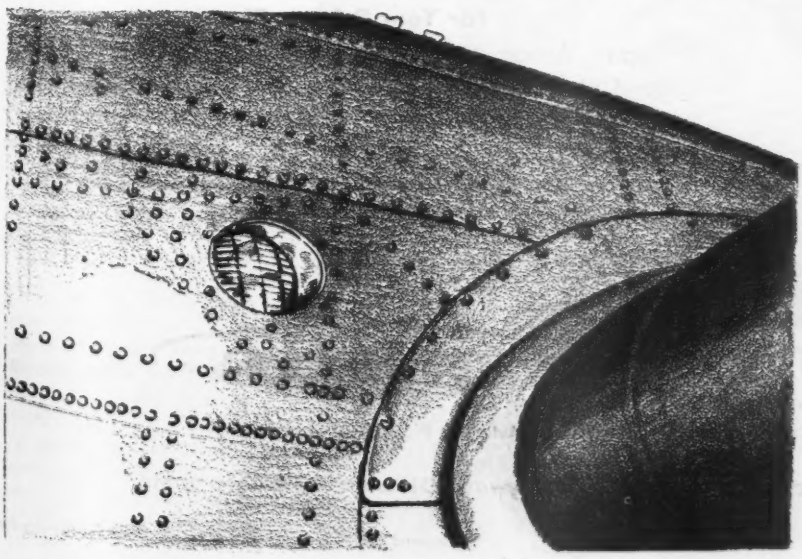
PROTECTION FOR FUEL CELLS

BOEING B-29 SUPERFORTRESS fuel cell wing cavities utilize bullet-protection linings of light flexible sheets of resin-impregnated Fiberglas cloth.

High impact strength of the lining material prevents "flowering" of cavity metal walls when struck by bullets and so insures the rubber fuel cell against protrusion, into its walls, of jagged metal petals which could otherwise render self-sealing characteristics ineffective.

EYE FOR ICE

A SIMPLE AND EFFECTIVE lighting installation for night flight use—especially designed to obviate difficulty in observing severity of ice accumulation on wings—has been devised by Chicago & Southern Air Lines personnel.



The ice light is recessed on the outboard side of the engine nacelle, just ahead of and above the wing leading edge. The light beam is directed out along the wing and permits ready observation, during flight, of the icing condition, making possible a higher percentage of flights completed, since the pilot may thus determine what to expect.

Use of a powerful flashlight had proved unsatisfactory because falling ice and snow reflected light rays back into observer's line of vision.

The ice-light installation has been adopted by other operators and is also being used on AAF cargo planes.

NO INSTRUMENTS!
NO CONTROLS!
NO FIDDLING!

"Propeller With A Brain" Varies Own Pitch . . . Steps Up Plane Performance Automatically!

Planning carefree trips, good times, in that postwar plane of yours? Then you'll want all the extra performance that *only* a variable pitch propeller can give you. But you won't want to fiddle with *extra* instruments or *extra* controls that take your attention and cramp your fun. Instead, you'll specify Aeromatic —the *only* propeller which automatically maintains correct pitch at all times.

Nothing Else Like It

Completely self-contained and self-acting, the Aeromatic Propeller automatically assumes the correct pitch for maximum performance under all flight conditions. That means up to 25% shorter takeoff runs . . . 33⅓% higher rate of climb . . . cruising faster and farther at the most favorable altitude . . . all with minimum fuel consumption and engine wear. Also, it means long, flat glides for happy landings . . . with an instantaneous change of pitch for a quick pickup if the pilot overshoots the field.

For Your Private Plane

Today, Aeromatic is used for military aircraft of 100 to 450 horsepower. Tomorrow, on your plane, it means greater ease and economy of operation . . . more get-up, more go, more fun. To manufacturers and others, engineering and performance data are available now. Don't hesitate to write.

The Propeller with a Brain for Tomorrow's Plane

Aeromatic

Air Controlled *Automatic Propeller*

KOPPERS Co., Inc., Bartlett Hayward Division, Baltimore 3, Md.

Licensed under patents of EVEREL Propeller Corporation

EFFICIENT ENGINE-DRIVE AFFORDS INSTANT PRESSURE FOR REPUBLIC P-47 WATER INJECTION SYSTEM

UTILIZATION of a direct engine drive instead of the ⅛-hp. battery-powered electric motor used with vane-type pump in Republic's P-47 Thunderbolt water injection system, insured an adequate instantaneous system pressure, eliminated drain on battery, and stopped system leakage entailed in process of operation.

With the ⅛-hp. motor, trouble was occasionally experienced in obtaining sufficient water supply. Also, it was necessary to operate the pump for several seconds to build up to required system pressure. To eliminate this pressure lag and the danger of pilot forgetting to initially operate the electric motor for driving the pump, the latter was run continuously so that pilot would have full water pressure at the exact moment emergency power was needed. This continuous pump operation constituted a considerable drain on the battery, approximately 8 amp. being constantly drawn.

And as load was removed from the series-wound motor when water in the system was exhausted, overspeeding resulted and the pump attained speeds far in excess of that recommended.

Considerable heat was developed, the pump seals dried out, and with successive operation of the system, leakage developed, and water occasionally seeped into motor and caused shorts.

These system disadvantages were overcome by using the alternate generator drive pad fitted with a reduction gear adapter designed to drive the pump directly from the engine.

The new drive, developed by W. A. Bohannon, Republic development engineer, fits any aircraft powerplant using a standard generator drive pad. Utilizing engine oil pressure in the adapter drive, more efficient lubrication is obtained as contrasted with grease lubrication for electric drive in former installation.

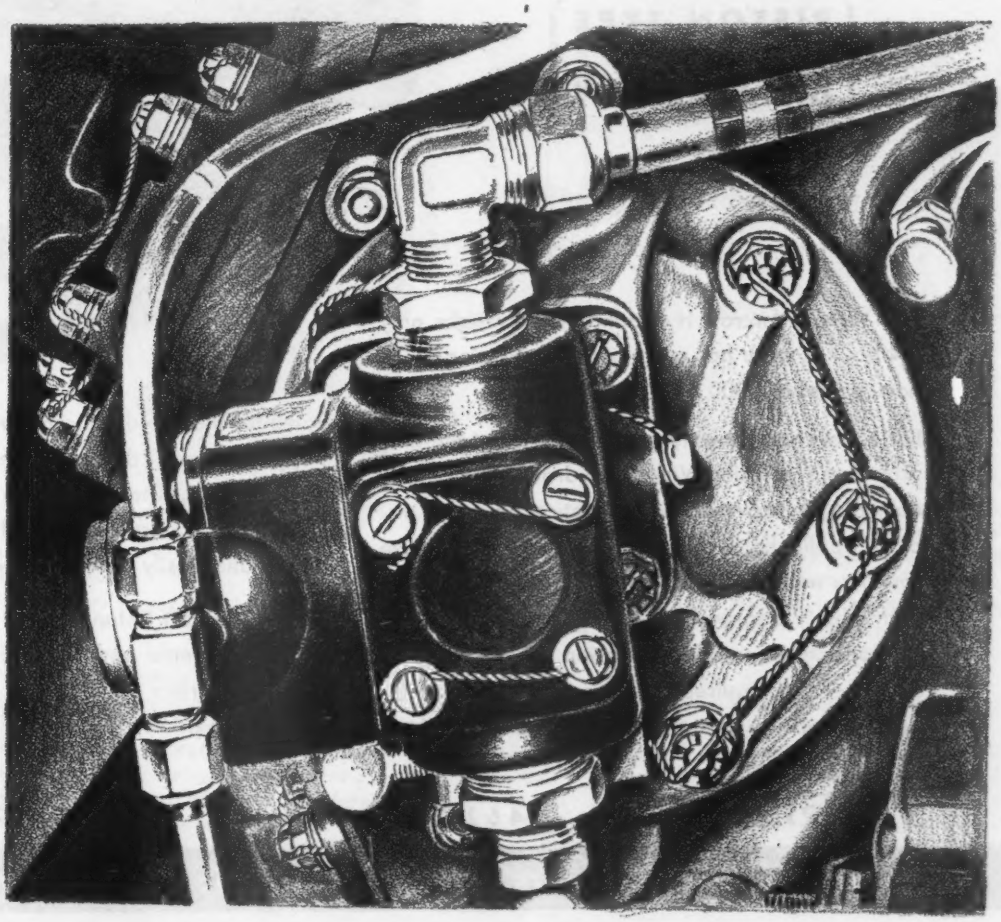
The pump operates at all times during engine operation, water being normally bypassed, but full pressure being insured when water injection is required. After water in system is used up, the pump continues to run at same speed, and it will operate dry indefinitely at this speed. The new hookup also permits use of a larger-capacity pump.

The shaft of the adapter driving gear is constricted in diameter to render it susceptible to torque reaction at that point and thus constitutes a shear-neck which is intended to yield and terminate the drive when the torque resistance of the driven accessory reaches a magnitude in excess of a predetermined safe value. This precludes imposition of unwarranted stresses on the power takeoff shaft and engine.

Direct hookup of pump to engine adds but a negligible load to the latter and eliminates the drain on the battery which was entailed with the original electric motor drive.

Easy accessibility is another feature of the new, less expensive installation. The adapter is designed for rotation through 180 deg., and there are matching drilled holes for oil passages. The pump is mounted eccentrically on the adapter, and with rotational feature of latter, it can be positioned to clear lines of other installations.

The former installation was mounted on the firewall, requiring special brackets, also conduits and wiring to switches for motor control. Access to the old installation was difficult, causing considerable inconvenience in the frequent inspections of electrical equipment and water lines.



Shown here is readily-accessible installation of direct engine-drive for pump in Republic P-47's water injection system. Pump is eccentrically seated on adapter for positioning (by resetting adapter rotationally) to clear tubing installations which may form obstructions in the area.

2.5 HORSEPOWER PER POUND

IS THE OUTPUT OF THIS

VICKERS AIRCRAFT HYDRAULIC MOTOR

(PISTON TYPE CONSTANT DISPLACEMENT)

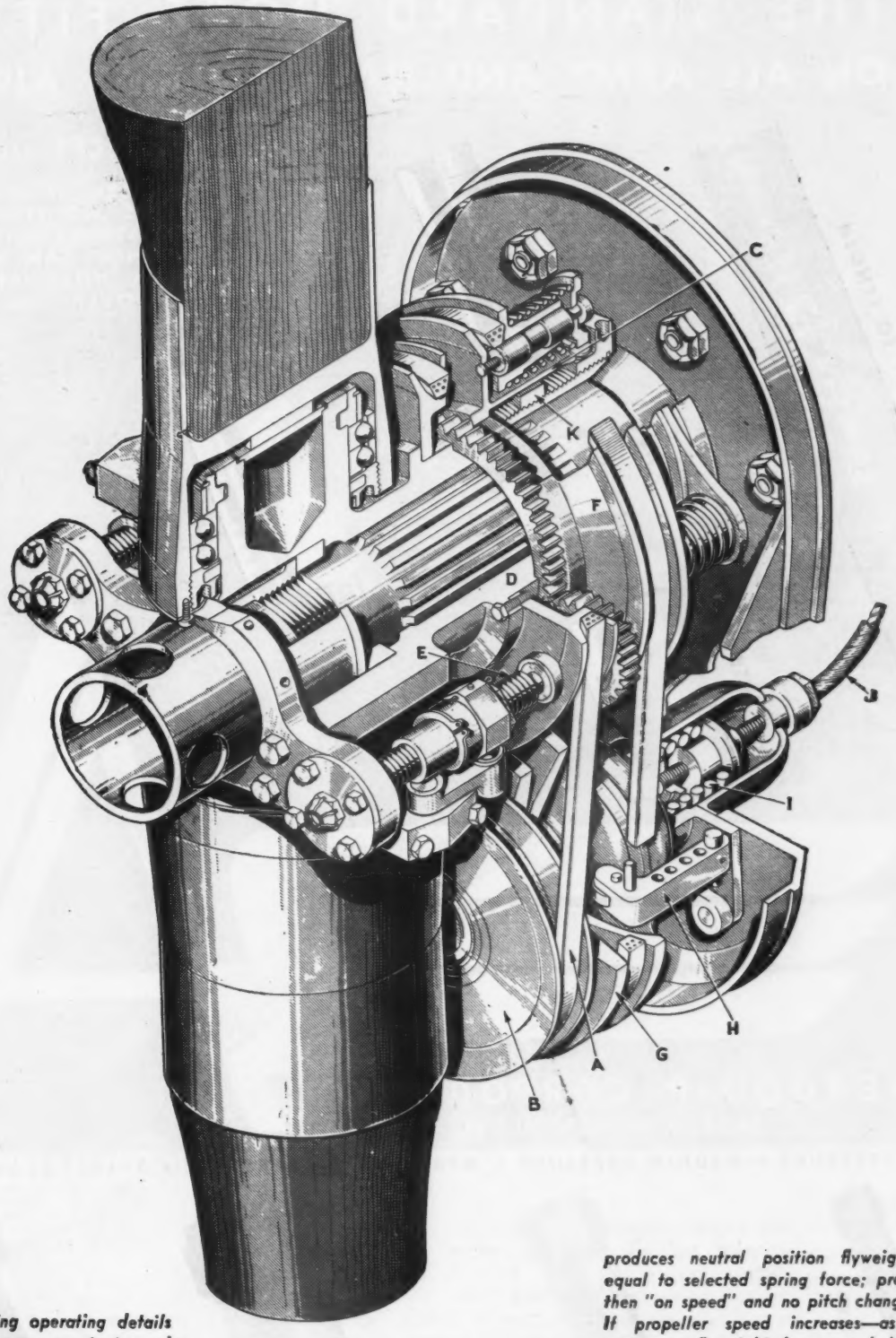
This Vickers Aircraft Hydraulic Motor weighs only 6.4 pounds yet it has a normal output rating of 16 horsepower at 3000 psi and 3750 rpm.

But a high horsepower/weight ratio is not the only advantage of using Vickers Hydraulic Motors for delivering rotary mechanical motion on many aircraft applications. These hydraulic motors save space as well as weight. Starting and stalled torque both closely approach operating torque. They can be stopped accurately to position. . . . No clutches or brakes are required. They are used for dynamic braking and can be stalled for long periods without damage. These hydraulic motors can be started and stopped instantly due to the very low inertia of the moving parts. They cause no radio interference. Reversal and accurate control of speed are very simply and easily accomplished.

Vickers Aircraft Piston Type Hydraulic Motors are inherently simple and rugged; they are available in a wide variety of models for operating pressures up to 3000 psi.

VICKERS *Incorporated* • **1462 OAKMAN BLVD.** • **DETROIT 32, MICHIGAN**

Engineers and Builders of Oil Hydraulic Equipment Since 1921



Cutaway drawing showing operating details of Zimmer-Thompson Iso-rev constant-speed propeller for small and medium-powered craft, utilizing variable ratio V-belt and split-pulley drive to effect pitch change. Governor shaft is driven by belt or chain (A) through pulley (B) at speed which is direct function of engine rpm. at fixed ratio. Hub sleeve (C) which can rotate in either direction relative to propeller hub (D), is connected to propeller blades by gear lead screws (E) so that when sleeve is turned faster than hub, pitch of blade is increased; when turned slower pitch is reduced.

Variable ratio drive connects sleeve to governor shaft. Ratio of variable pulleys (F) and (G) is controlled by speed-sensitive flyweight governor mounted on governor shaft. When flyweights (H) are displaced, outward pulley halves on governor shaft are brought together so that ratio of variable drive exceeds that of fixed drive, causing sleeve to rotate faster than hub and thus increase blade pitch. Centrifugal force of flyweights is opposed by spring (I), which is adjustable in flight through control (J).

Propeller will operate at speed which produces neutral position flyweight force equal to selected spring force; propeller is then "on speed" and no pitch change occurs. If propeller speed increases—as through maneuver—flyweight force overbalances opposing spring force and weights move out to increase effective diameter of variable pulley, changing ratio to drive sleeve and changing blade pitch.

Pitch limit is accomplished by threading hub under sleeve and providing stop nut (K). Studs on nut protrude through slots in sleeve, thus requiring nut to turn and travel when sleeve rotates relative to hub. At end of travel, nut engages lugs on movable half of pulley, thereby causing ratio of variable drive to equal that of fixed drive. These being equal, there is no further pitch change.

'THE STANDARD HOSE FITTING'
ON ALL ARMY AND NAVY COMBAT AIRCRAFT

3 PIECES *(EACH REPLACEABLE)*

ASSEMBLY WITHOUT SPECIAL TOOLS. NO TIGHTENING OR ADJUSTMENT AFTER ASSEMBLY. FITTINGS CAN BE REMOVED FROM HOSE AND RE-USED OVER 100 TIMES.

AEROQUIP CORPORATION
JACKSON, MICHIGAN, U. S. A.

LOW PRESSURE • MEDIUM PRESSURE • MEDIUM HIGH PRESSURE • BULLET SEALING HOSE LINES

303 WAREHAM BLDG., HAGERSTOWN, MD.—1709 W. 8TH, LOS ANGELES—PRENCO—72 STAFFORD ST., TORONTO, ONT.

Here (immediately above) is double-acting hydraulic landing gear retracting jack for main landing gear of de Havilland Mosquito. Piston end (A) attaches to right leg of landing gear structure. Spring-loaded mechanical safety latch (B), incorporated in lower fitting, secures landing gear in down position. Engaging collar on jack ram, it can be released only by hydraulic pressure on safety valve when landing gear is being raised. Upper fitting (C) attaches to yoke mounted on front face of rear wing spar. Detail sketch (top) shows retracting jack at (A) in order to depict its relationship to landing gear as a whole.

lation

THE EVENING NEWS

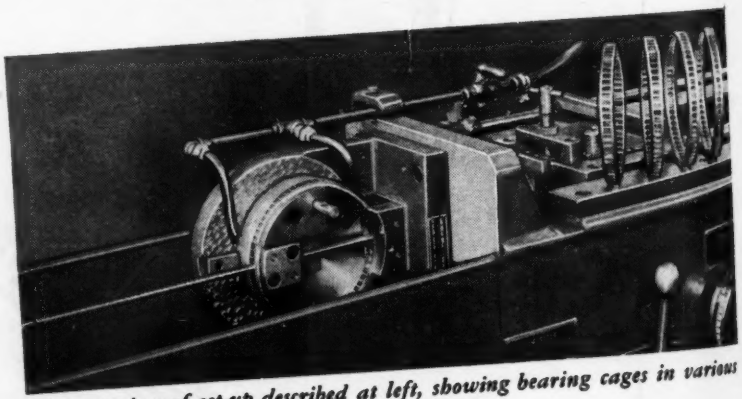
FINAL

RECONVERSION PROBLEM SOLVED!

American H-2-30 STANDARD BROACHING MACHINE ADAPTED TO MANY "SPECIAL" JOBS!

ABOVE: *Standard American H-2-30 Horizontal Broaching Machine reconverts easily from war to post-war production.*

This standard *American* broaching machine, designed for use in many types of war production, is cheaply and quickly converted to peacetime manufacture. Considerably less expensive than especially built equipment, it will perform a large number of "special" jobs accurately and economically.



Close-up view of set-up described at left, showing bearing cages in various stages of completion.

The set-up for one such job is illustrated at the right: To broach rectangular holes in aircraft bearing cages. Two opposite holes are broached at each pass. Starting with a drilled hole, three passes, each with a slightly larger broach, are required for each hole. Exceptional finish at a high production rate is assured.

American's complete broaching service—machines, tools, and engineering—is available to speed your production. Let *American* engineers help solve your precision manufacturing problems with standard machinery that will save you valuable time and money. Write for further details.

Use proper and sufficient lubrication when broaching. It is cheap life insurance for broaching tools.

MEMBER BROACHING TOOL INSTITUTE

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BROACH AND MACHINE CO.

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BROACHING MACHINES
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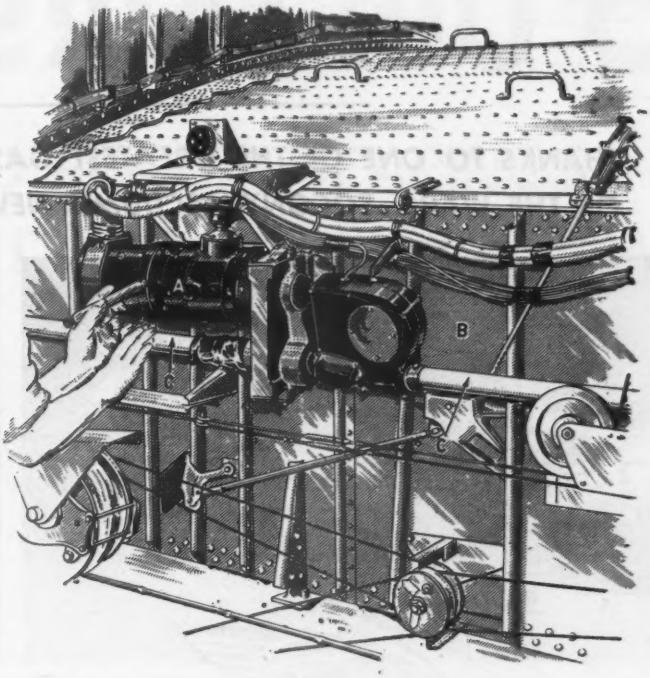
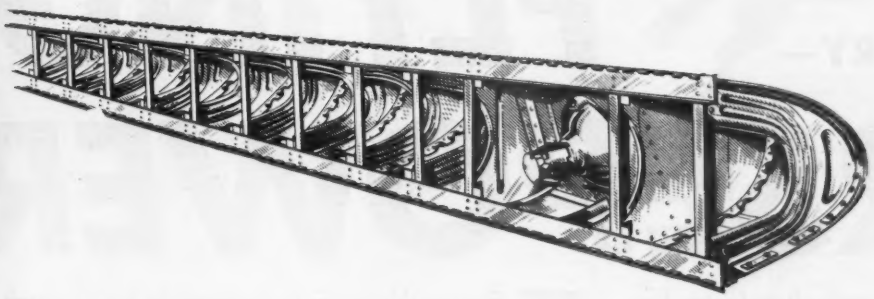
SPECIAL MACHINERY

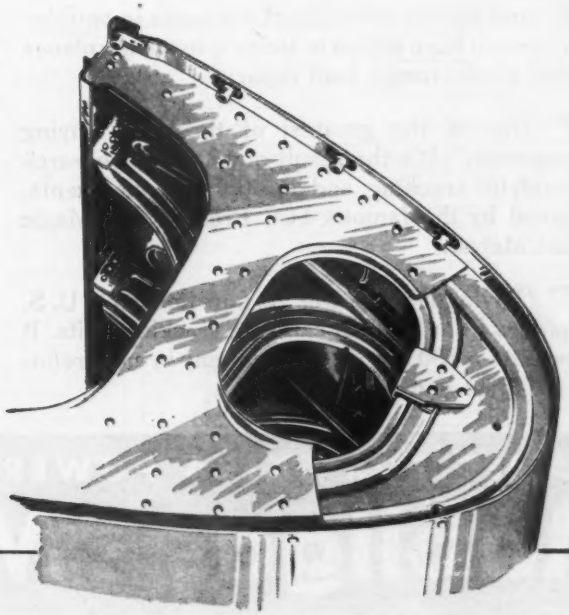
DIVISION OF SUNDSTRAND MACHINE TOOL CO.



Flap actuator motor (A) on Boeing B-29 Superfortress is located on aft face of rear spar (B). Through internal gear reduction, the 24v. 31-lb. 4-oz. motor develops 1,500 lb.-in. torque on torque tubes (C).



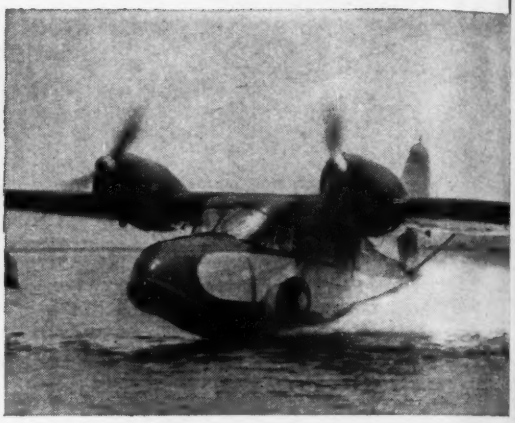
Part of leading edge of Martin B-26 wing (above) attaches to main portion via piano hinges. This design not only facilitates production, but removal of one hinge wire permits quick access to grouped plumbing and wiring leading out from fuselage to engine nacelles. Detail of nose rib construction is shown at right.



Commercial Planes... Private Planes...

GO UPSTAIRS FASTER

THANKS TO ONE OF THE GREATEST GASOLINE DEVELOPMENTS OF THE WAR... SOCONY-VACUUM'S NEW SUPER FUEL POWER!



AFTER VICTORY—

FLYING HORSEPOWER

In three war years the aircraft industry has made sensational advances in aircraft design and operation.

And equally sensational advances in petroleum research have added to today's super warplanes greater climb, range, load capacity.

One of the greatest of these is "Flying Horsepower." It's the result of 11 years' research in catalytic cracking and multiple developments, climaxed by the famous TCC Process and Magic Bead Catalyst.

"Flying Horsepower" is now flowing to U. S. warplanes from 19 great catalytic cracking units. It represents a $90,000,000 investment in new refining facilities and equipment.

Socony-Vacuum is continuing its research in "Flying Horsepower." After Victory, peacetime aircraft designers, builders and operators may expect an even greater fuel power for tomorrow's private and commercial planes.

SOCONY-VACUUM OIL COMPANY, INC., 26 Broadway, New York 4, N. Y., and Affiliates: Magnolia Petroleum Company; General Petroleum Corporation of California.

TEAMED FOR EXTRA POWER—

Mobilgas · Mobiloil Aero

BALL AND ROLLER BEARINGS STANDARD SPECIFICATIONS

THE BALL AND ROLLER BEARINGS to which the tabulated data given below refer are commercial products standardized by the American Standards Assn., Society of Automotive Engineers, and Annular, Thrust & Roller Bearing Engineers Committees. However, internal construction and design details are not parts of these specifications.

Ball bearings are standardized in the following types:

BA—Angular contact single-row singly mounted.

Note: Bearings for duplex or multiple mountings such as back-to-back, face-to-face, or in tandem are indicated by addition of the suffix "F" to the bearing code number. This code number indicates one bearing only.

BC—Radial single-row non-loading groove assembly.

BL—Radial single-row, loading groove assembly.

Note: Addition of shields on one or both sides or snap ring on outer race in types BC and BL is indicated by addition to the bearing code number of the following suffixes: P shield on one side; PP, shields on both sides; G snap ring on outer race; GP, shield and snap ring on the side opposite shield.

BD—Angular contact double row.

BH—Radial single-row counterbore assembly.

BM—Single-row separable.

BS—Self-aligning double-row.

BIC—Radial single-row non-loading groove assembly, inch dimensions.

BT—Thrust single-direction flat face.

BTS—Thrust single-direction self-aligning.

Cylindrical roller bearings shall be in the following types:

RN—Cylindrical single-row, flanged inner, straight outer race.

RU—Cylindrical single-row, flanged outer, straight inner race.

RF—Cylindrical single-row, one-direction locating, outer race separable.

RJ—Cylindrical single-row, one-direction locating, inner race separable.

RP—Cylindrical single-row, two-direction locating, one outer race flange separate.

RUP—Cylindrical single-row, two-direction locating, one inner race flange separate.

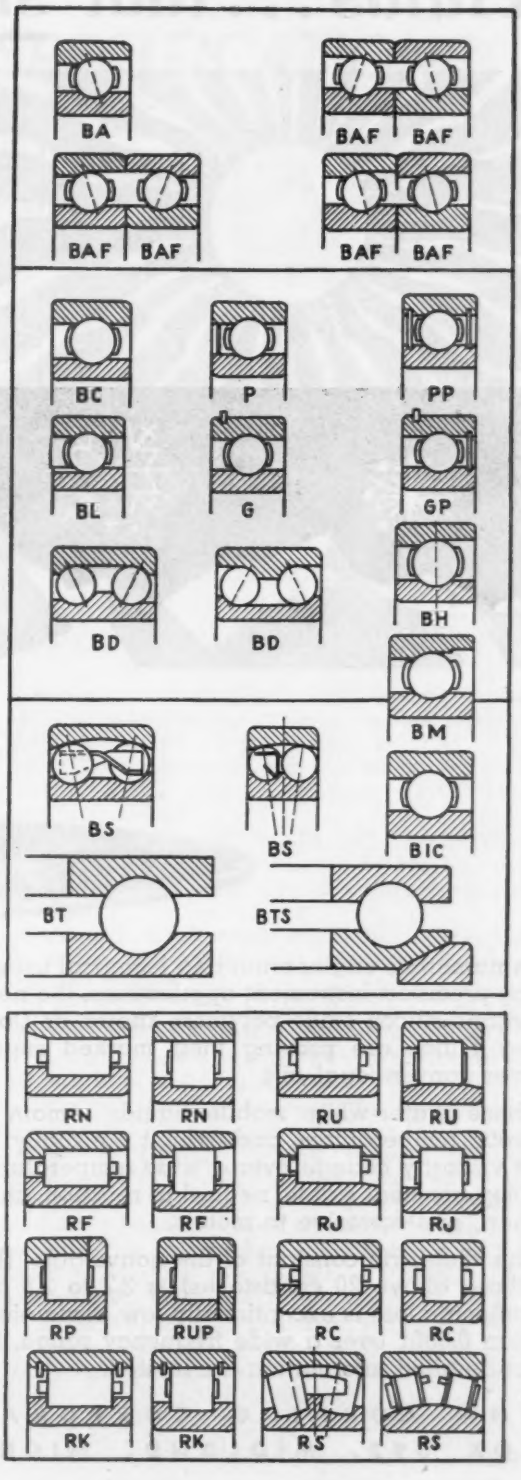
RC—Cylindrical single-row, self-contained, two-direction locating.

RK—Cylindrical single-row, self-contained, not locating. For designating Type RK with full roller complement, the suffix "V" is added to the bearing code number.

Note: For locating shafts axially, flanges must be used. For retaining rollers and for axial location of outer rings, snap rings or recesses may be used instead of flanges.

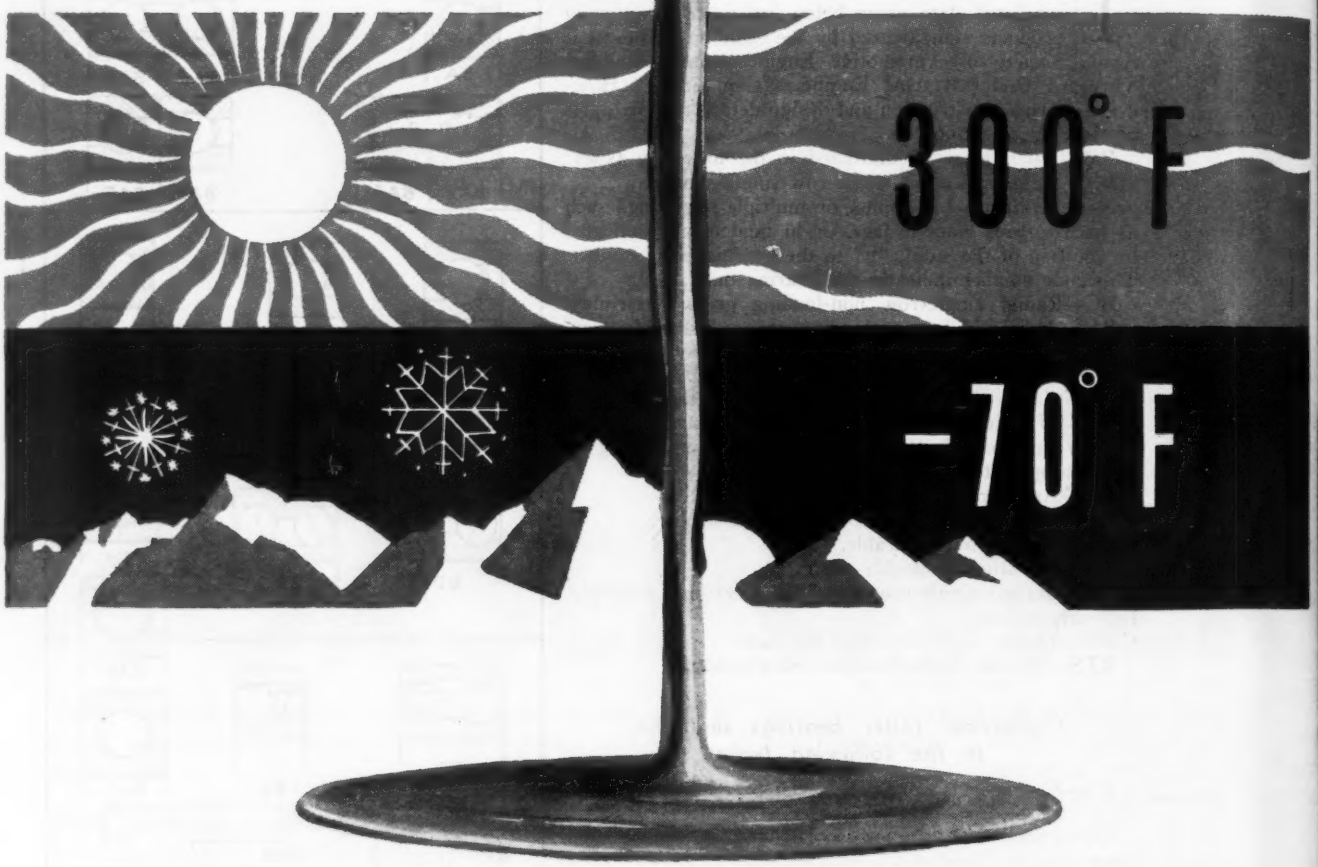
Spherical roller bearings shall be in the following type:

RS—Self-aligning double-row with roller path of inner or outer race spherical.



DC FLUIDS

Fluids . . . that stay fluid all the way!



In numerous engineering and technical uses, including precision instrument applications, the new liquid organo-silicon-oxide polymers known as Dow Corning Fluids are proving their marked superiorities over conventional oils.

These water-white mobile liquids remain fluid at arctic temperatures, and exhibit unusually low rate of viscosity change over a wide temperature range. They are heat stable, neutral in reaction, chemically inert, non-corrosive to metals.

The dielectric constant of the nonvolatile DC Fluids (those above 20 centistokes) is 2.7 to 2.8 and their dielectric loss is exceptionally low, remaining at less than 0.0001 over a wide frequency range. Inquiries for detailed information are invited.

DOW CORNING CORPORATION
BOX 592, MIDLAND, MICHIGAN

DOW CORNING FLUIDS COME IN TWO TYPES:

TYPE 200—commercially available in five viscosity grades—100, 200, 350, 500 and 1,000—in centistokes at 25°C.

TYPE 500—commercially available in ten viscosity grades—0.65, 1.0, 1.5, 2.0, 3.0, 5.0, 10, 20, 50 and 100—in centistokes at 25°C.

Dow Corning

BALL AND ROLLER BEARINGS STANDARD SPECIFICATIONS

Tapered roller bearings shall be in the following types:

TS—Tapered rollers single-row.

TSS—Tapered rollers single-row steep-angle.

Note: Any single cone listed in tables of types TS and TSS can be used with flanged outer race (Type TSF) or double-row (Type TDO) in the same series.

TST—Tapered rollers, single-row, tapered bore.

TSF—Tapered rollers, single-row, flanged outer race.

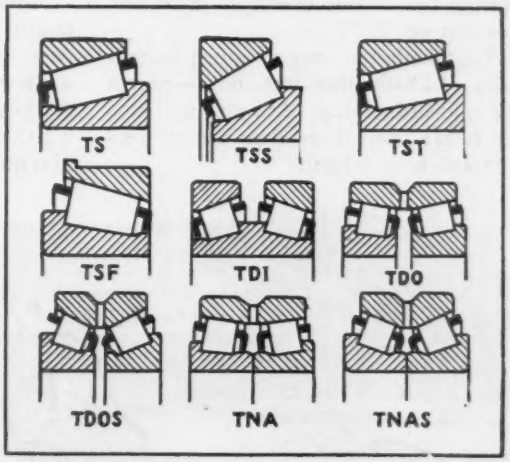
TDI—Tapered rollers, double-row, single outer races.

TDO—Tapered rollers, double-row, single inner races.

TDOS—Tapered rollers, double-row, single inner races, steep angle.

TNA—Tapered rollers, double-row single inner races, non-adjustable.

TNAS—Tapered rollers, double-row, single inner races, non-adjustable, steep angle.



Code for Indicating Bearing Size and Type

For a ball bearing of any type except BM, BIC. BT, and BTS, and for a cylindrical or spherical roller bearing, the code number shall consist of: Bearing *bore* in millimeters; *type* letters; two numerical digits indicating *dimension series* in accordance with the ABEC and RBEC *General Plan for Boundary Dimensions,* the first figure indicating *width* series and the second *outer diameter* series. *Example:* No. 50BC02 indicates a ball bearing of radial single row construction and non-loading groove assembly with 50-mm. bore in dimension Series 02, i.e. 20-mm. width and 90-mm. outer diameter.

For ball bearing BM, the code number shall consist of: Bearing *bore* in millimeters; *type* letters; *outer diameter* in millimeters. *Example:* No. 10BM28 indicates a ball bearing of separable type with 10-mm. bore and 28-mm. o.d.

For ball bearing BIC, the code number shall consist of: Bearing *bore* in sixteenths of an inch; *type* letters; bearing *outer diameter* in sixteenths of an inch. *Example:* No. 12BIC26 indicates a ball bearing of radial single row construction with *inch* dimensions and non-loading groove assembly with $\frac{3}{4}$ inch bore and $1\frac{5}{8}$ in. o.d.

For thrust ball bearing BT and BTS code number shall consist of: Bearing *bore* in millimeters; *type* letters; one of the letters "L" for *light* and "M" for *medium. Example:* No. 115BTM indicates a thrust ball bearing, single direction with flat face, of medium series, with 115-mm. bore.

For a specific tapered roller bearing the code number shall consist of two numbers, the first indicating the cone and the second the cup as given in the tables. Tolerance specification shall be included in the purchase order. *Example:* Bearing 14125A-14276 specification 4B.

Suffixes, such as "F" for BA, "P", "PP", "G", or "GP" for Types BC and BL, or "V" for RK, shall be added in alphabetical order directly after the code number.

Internal fit between balls or rollers and races shall be in the code number only when deviating from standard internal fit. In such cases the capital letters "L" or "T" are added to the code number after the suffixes enumerated above. *Example:* No. 50BC02PT is a single shielded bearing with tight internal fit between balls or rollers and races.

Tolerance specifications, except for tapered roller bearings, shall not be indicated in the bearing code number for bearings made to standard tolerance specification "1". Only in those cases where the tolerances of specifications "3" or "5" are applied, shall the tolerance specification number be appended to the bearing code number; in such cases it shall be separated from the code number by a dash—as, for example, No. 50BC02PT-3.

Hardness of bearing rings, balls, and rollers, taken on Rockwell C-scale, shall be 58–68, depending on bearing size and material.

(*To be continued*)

Side Slips

BY APPLYING common-sense methods, the two efficiency "experts" had increased a certain base's engine overhaul output by a very good margin. On the strength of the deal, they got themselves sold to an airline; for $1,800 they were to spend two weeks analyzing its engine overhaul set-up and show it how to save some money.

At the end of the two weeks, they bustled into the superintendent's office, loaded down with charts, blueprints, and a very flashy report. "Mr. So-and-so," they beamed, "we have it all figured out so that, instead of just getting ten engine overhauls a month, you can get 90!"

To which the super replied laconically; "That's just fine, boys—except for one little thing. Around this shop we never have more than ten engines a month to overhaul."

• Sliding into the only available seat of an airliner the other night, we found ourself next to a very tired service man who was doing some Grade A snoring. He could be heard all over the plane, even above the clatter of a hurried cargo-shifting job. He kept right on snoring through the engine starts, a long taxi run, the engine run-ups—even the takeoff.

But, as soon as the engines settled back to cruising speed, the snoring ceased and he slept in absolute silence till the next landing, when he again started sawing loudly, continuing again till after the takeoff.

Although the medical profession might like to have this discovery, we pass it on first to traffic salesmen to work on weary wives with this slogan: "If your husband snores, just buy him a ticket on our airline and let us keep him quiet."

"Maguire sure was smart — making that one resolution to stay on the job."

• Manufacturers who have built planes designed by other airplane concerns' have squawked plenty about the drawings furnished by the original designers. Seems, however, that it doesn't happen just in this country; our Canadian neighbors have similar headaches inherited from the tight little isle across the sea. One Canadian worker—who had best remain anonymous for job-protection purposes—sent in the following after long eye-straining hours spent working on Lancaster drawings:

'Ell For Lanky

We might fling nasty swearwords
At you men across the sea
Instead, let's just discuss it
O'er a friendly cup of tea.

What ho! You English draftsmen
With your "starboard" and your "port"
Your prints are not quite cricket
Rather baffling . . . of a sort.

You are bully in a blackout
But might have waited, don't you know
Until the lights went on to draw
These prints by A. V. Roe.

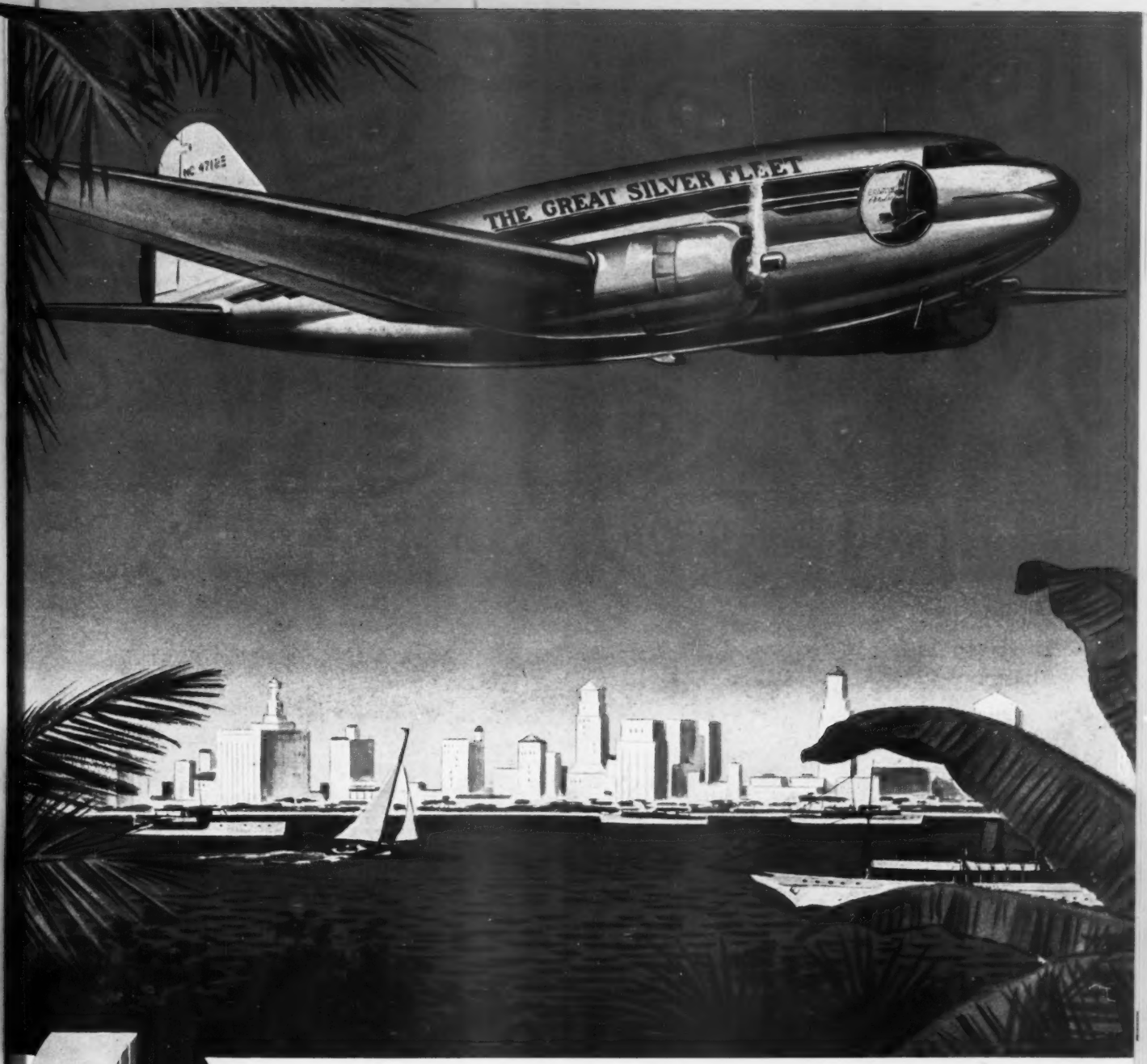
No doubt, your system's jolly
And a bit of all-right, too
And we might appreciate it
Were we be-monocled like you.

We are grateful for the contract,
Simply ripping of you blokes.
Small matter if we lose our sight
On these items and these strokes.

Dear chaps across the ocean
Help preserve our etiquette
Please forward next Assembly
Complete with one lorgnette!

• Like many others, we try hard to figure the precise value of strategic bombing in the weighty scales of modern warfare. Only our calculations never seem to add up, and that's given us a very dismal suspicion—a suspicion that maybe our own *personal* powers of military assessment are of sub-minus grade.

Other day, though, we brightened up considerably. Seems there are other fellows just like us—expert fellows, in fact. It was a well-known war correspondent's radio to the New York *Times* that made us feel better. "General Giraud," his message read, 'is convinced that the general strategic bombing of German cities has been futile. At the same time, he is aware of its crucial importance."



EASTERN Air Lines

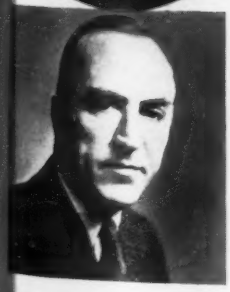
...counts on Curtiss Commandos

FOR MORE FREQUENT AND FASTER SERVICE

As part of a $25,000,000 domestic and international expansion program—that will multiply its mileage by five times in a three year period and by approximately ten times in five years—Eastern Air Lines is adding the Curtiss Commando, world's largest and fastest twin-engined transport, to its Great Silver Fleet.

This selection was the result of Eastern's two years' experience, operating a fleet of Commandos for Air Transport Command on regular schedule. Under ATC direction, Eastern Air Lines pilots flew Commandos more than ten million miles, largely over water to South America and Africa.

Originally developed by Curtiss-Wright in cooperation with airline engineers as a commercial transport, the Commando with its powerful 18 cylinder Wright Cyclone Engines, meets a definite demand for larger payload, greater reliability and reduced operating costs on flights up to 700 miles in length—a range that covers over 90% of all domestic air travel. *Look to the Sky, America!* Curtiss-Wright Corporation, Airplane Division, Buffalo, New York.



r new medium range Commando verliners will be particularly well apted to Eastern's frequent flight hedules linking practically all princi- cities in Eastern, Middle Western d Southern States.

EDDIE RICKENBACKER
President and General Manager
Eastern Air Lines

COUNT ON Curtiss-Wright FOR ACHIEVEMENT IN THE AIR

Member Aircraft War Production Council East Coast, Inc.

Grumman Hellcats—U. S. Navy Spearhead

Grumman

AIRCRAFT ENGINEERING CORPORATION, Bethpage, L. I., N. Y.

...So You're Going to Buy A Used Airplane?

By E. F. LINDSLEY

Before saying, "I'll take her," you'll wisely "screen" this detail, that point, and the other factor. Outlined here are the pertinent questions of just what to look for and just what to check in a used ship—in order to get answers which will sum up in terms of dollars, sense, and safety.

SOME KNOWLEDGE OF THE PRODUCT is always of prime aid in the consideration, selection, and buying of a used anything, and that, of course, goes for a used airplane.

Granted, this approach to our subject is as trite as two and two equalling four—but it leads us directly to the specific point that assurance of a satisfactory purchase depends upon how practically the prospective plane buyer collates and employes his knowledge. Our purpose here is a consideration of what to look for and what to check.

With the ever-watchful Civil Aeronautics Authority in the background and with local CAA inspectors prepared to interpret the Civil Air Regulations, the initial question, when eyeing a used aircraft with intent to buy, is "Can this plane be granted a license?" Normally, if the ship has been used for ordinary civilian purposes, the answer will be "Yes." No doubt previous licenses have been issued, the manufacturer having originally complied with all CAA design and test regulations and thus obtained an Approved Type Certificate.

The CAA will continue to approve a license—as long as the plane is maintained in first-class shape by authorized mechanics, as long as it undergoes no unauthorized structural changes, and as long as the local CAA inspector believes the plane to be airworthy.

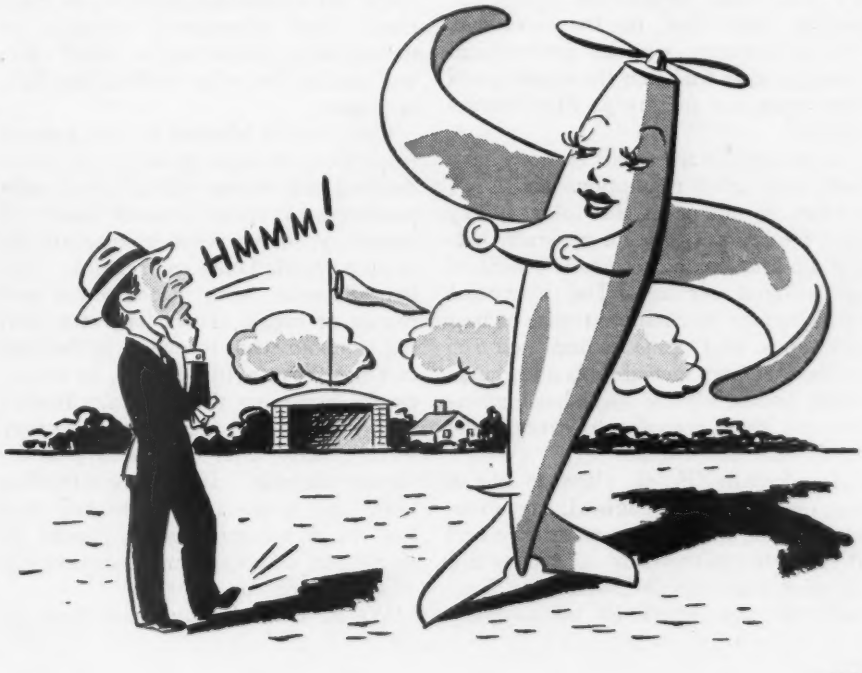
Let us suppose, however, that the craft is a used military airplane. The Services have some excellent planes in the low and medium power classes that could easily be adapted to private uses. Purse permitting, a civilian may have an urge to buy something really "hot", say a pursuit or advanced trainer type. In any event, such craft become *civilian* planes once they are sold out of the military, hence a civil license will become mandatory.

It may be assumed that the plane has certainly proved its worthiness in the flak-filled skies of war, but if the manufacturer designed and built it exclusively for the military, it is not likely that he gave much consideration to the matter of an ATC. Should he attempt to gain a civilian approval now, there arises the probability of extensive design changes and costly testing to meet requirements. Of course he might design, build, and sell conversion kits to permit non-factory mechanics to rebuild the plane into a licenseable hybrid. Or he might allow the planes to return to his factory for conversion. We say he *might* do these things. But it would hardly make much economic sense. These military planes are already of the past—bought and paid for. The manufacturer's interest will rightly center on promoting new sales of new models.

The implication is clear. If a man still longingly eyes a purchaseable military airplane, he should first ascertain its make and model with utmost care, then query the manufacturer and the local CAA office. And, if any doubt whatever remains as to the plane's chances for a license, the CAA at Washington should be contacted.

Now the question: "When was the last overhaul on this ship?" Government requirements enforce such high maintenance standards that each repair or replacement parallels, from an engineering standpoint, the original strength of the repaired member. However, the purchaser of a fairly old airplane may find himself involved in an expensive major overhaul the next time his plane comes up for license renewal. On this point, the airplane and engine log should be consulted prior to purchase.

Indeed, importance of the log cannot be overstressed. Legally, no repair, replacement, or change, may be effected on a licensed aircraft without an accurate log notation and description preceding the signature of the licensed mechanic responsible for the job. It is the owner's legal obligation to maintain the log. Certainly, the prospec-



tive purchaser will be wise to examine it carefully before buying.

A carelessly kept log suggests similar maintenance. And an owner's refusal to exhibit his log may be taken as a warning that something more is awry.

Things to look for in the log: Has the plane ever been crashed? . . . How many major overhauls have been made so far? . . . What was the period of time between engine overhauls? . . . Is the plane approaching another major overhaul period? . . . Who maintained the ship—a licensed mechanic, an authorized repair station or dealer agency, or the factory? . . . Have minor discrepancies been entered as carefully as major troubles? From the purchaser's standpoint, the answers to these questions mean dollars, sense, and safety.

If a plane has had more than two major overhauls it may best be suited to the professional purchaser who can command ample maintenance facilities to keep it tuned after the inevitable wear and tear accumulated over the years.

At best, no two planes fly alike. A badly crashed ship may be rebuilt to a structural perfection yet evidence thereafter some strange flight characteristics. Briefly spaced engine overhaul periods suggest engine abuse; excessively long periods, while indicative of careful operation (and maybe good luck), may prove to be the results of financial stretching by the owner. If a major overhaul will be due within the next 50 or 100 hr., the buyer must be prepared to spend a very considerable sum after his purchase.

Anent the Orphans

Another thing is that many prewar airplanes are now orphans, their builders having been absorbed in war industry and their production equipment having been lost in the scramble. Private owners, without professional contacts, may find that the repair parts they want are as rare as Stradivarius violins.

Since authorized repair stations have both their good reputations and CAA ratings to maintain, the planes they care for are apt to be in generally better condition than those sans benefit of professional service. The individual small-airport mechanic, in spite of best intentions and conscientions efforts, cannot, lacking special tools and equipment, handle all the specialized maintenance items common to every make of airplane and engine.

Incidentally, if one plans to buy a super-deluxe, multi-engined, executive-class plane, the average man may find it best to commission a recognized aviation expert to do his buying. I recall one case where an oil company executive, rather poorly founded in aviation lore, purchased an historic six-place airplane for executive transport use by his company. Unfortunately, he found after purchase that another $25,000 would be needed to rebuild his $50,000 relic into licenseable shape; for the plane's hard history in experimental and racing lines had finally made it unacceptable as a safe transport. It doesn't require much imagination to picture the board members' faces.

Looking One Over

Now let us assume that we are walking across an airport apron, notebook in hand, to examine a prospective purchase, say a light or medium-weight plane in the one-man-ownership class. Our first view of the ship, from about 50 ft., will afford a broad survey of its appearance, and since there is wide latitude in color schemes of airplanes, we can get a reflection of the individuality of the owner. Maybe the color scheme will be too flashy for our own personal liking, or maybe too dignified. Well, every man to his own taste. Anyhow, new colors can be applied.

On the other hand, an old, dirty finish can indicate a "let it go" attitude on the part of the owner. Then again, there may be the old business of a new paint job put on merely for sales purposes, conceivably to cover faults.

Let us walk around the plane while still some distance away. A slightly canted attitude of the craft does not necessarily mean the landing gear is awry. Shock struts may stick slightly on one side, or the pressure in one strut may be somewhat low. This may be checked by rocking the plane.

We should watch the highlights on the fabric or metal covering. Patches, overlying major repairs, will often stand out as slight differences in color tone. And advertising emblems or names, once painted out or doped over, will nearly always be visible if the light is proper.

Our interest whetted by this general inspection, we now go on to the more detailed task of note-taking. And we're prepared to spend several hours if necessary, for we want an accurate list of all probable faults and repairs. This list, discussed with a competent mechanic or repair station operator, will tell us about what to expect in the way of repair costs. In addition, by realistically discussing the necessary repairs with the local CAA inspector, we may learn exactly what is necessary to relicense the ship. If the inspector has been long in the area, a checkup may lead to added information should he recall and elaborate on circumstances of past repairs on the ship.

We have headed our four-sheet inspection pad (a legal size, ruled columnar pad) with the four titles, Wings, Fuselage, Tail Surfaces, and Engine. Now we will give all structural surfaces the same basic inspection for appearance, alignment, evidence of wear, deterioration, and damage, therefore, we divide the first three sheets into convenient subheadings for note taking, leaving the fourth sheet—the engine page—blank for now.

A professional inspector, using a specially printed form, might accomplish this checkup so scientifically that no revision would be needed to estimate repair costs. On the other hand, our time spent balancing our notes will help familiarize us with the plane. We'll simply jot down our observations.

When the critical fisherman considers a flyrod, he checks it for kinks, bends, and undesirable undulations, by squinting with half closed eye down the rod's varnished length. Why not apply the same technique to our airplane? From a kneeling position directly astern, our eyes will reveal ripples, twists, and bends in the main longitudinal members or longerons and stringers. Any deviation from the smooth curves of symmetry requires investigation.

Lumps or sharp bends sometimes announce welded repairs and splices. Should the movable and fixed tail control surfaces seem out of line when sighting on the wings as a horizon, we'd better have a mechanic check the rigging before we buy. Obviously, our squints along the margins of the tail surfaces will be worthwhile.

Our eyes sharpened, let's take a look from each wing tip. By sighting along the leading and trailing edges we ought to spot such bumps, dents, and warps as would suggest minor taxiing accidents or the collisions when ships are rolled about the hangar.

Now we're feeling a little sharper at this critical observation technique. We spot an oil film on the plane's belly, and that could mean a serious leak or, perhaps, it may have been caused only by a careless oil-spilling mechanic.

Structural Checkups

Naturally, any thorough checkup, short of some actual disassembly, must include a few more rugged inspection procedures. These procedures are, of course, pertinent if our discussion here is really to cover the points.

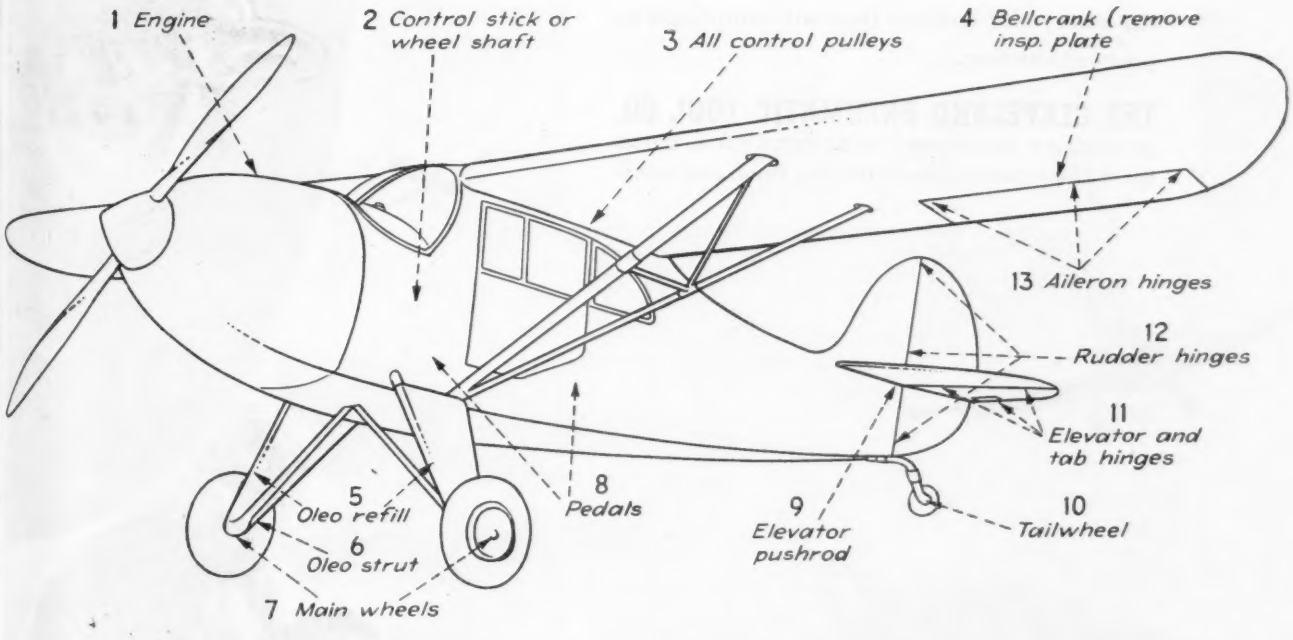
So we assume we have opportunity to continue our check, as described in the following paragraphs. We are not planning to damage the ship, just prove the condition of certain hidden joints and structures.

We grasp a wing tip firmly, then

(*Turn to page 262*)

AVIATION'S LUBRICATION CHART FOR AERONCA

Models: Defender, Trainer, Scout, and Super Chief



Engine. Uses SAE 40 (AN-VV-O-446A, grade 1080) in summer and SAE 30 (AN-VV-O-446A, grade 1065) in winter.

Above grades of oil are used at all points indicated except control pulleys (3) where powdered graphite may be substituted.

Oiling should be performed *every 100 hr.* under favorable conditions, but joints should be washed with gasoline and relubricated *every 25 hr,* if ground conditions cause them to become dusty.

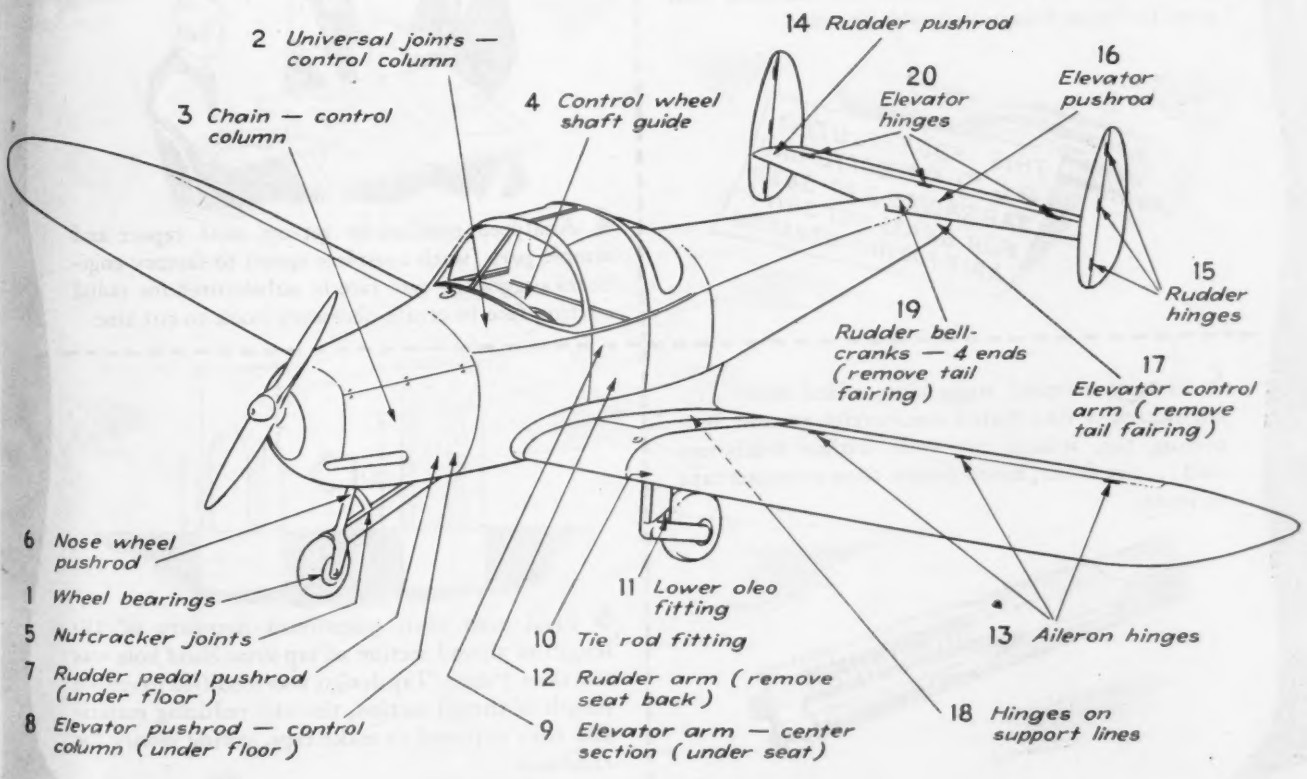
High temperature grease 3560E or AN-G-5 should be used for wheel bearings.

Shock struts should be filled with type of hydraulic fluid specified on plate on cylinder. Since mineral base oil destroys natural rubber seals, castor oil should be used when seals are of this material (see article, *"How To Look After Those Aerols,"* page 169, Aug. 1944 AVIATION).

"Cut"—
It's a perfect approach to the carrier deck, so the signalman waves his paddles, telling the pilot to "cut throttle" on the engine. Now, the landing gear must complete the smooth landing—a job which Aerols efficiently perform with their reliable, shock-absorbing action.
Landing on a rolling flat-top typifies the tough tasks Aerols are handling today . . . forecasts the safety and comfort they will contribute to postwar aviation.
THE CLEVELAND PNEUMATIC TOOL CO.
AIRCRAFT DIVISION • CLEVELAND 5, OHIO
Speed Final Victory! Buy MORE War Bonds and Stamps
AEROLS
*PNEUMATIC-HYDRAULIC (AIR-OIL) SHOCK ABSORBING LANDING GEAR

AVIATION'S LUBRICATION CHART FOR ERCOUPE

Model: 415-C


2 Universal joints — control column
3 Chain — control column
4 Control wheel shaft guide
14 Rudder pushrod
20 Elevator hinges
16 Elevator pushrod
15 Rudder hinges
19 Rudder bell-cranks — 4 ends (remove tail fairing)
17 Elevator control arm (remove tail fairing)
6 Nose wheel pushrod
1 Wheel bearings
5 Nutcracker joints
7 Rudder pedal pushrod (under floor)
8 Elevator pushrod — control column (under floor)
11 Lower oleo fitting
10 Tie rod fitting
12 Rudder arm (remove seat back)
9 Elevator arm — center section (under seat)
13 Aileron hinges
18 Hinges on support lines

Engine. Uses SAE 40 (AN-VV-O-446A, grade 1080) in summer and SAE 30 (AN-VV-O-466A, grade 1065) in. winter.

Above grades of oil are used at all points indicated on diagram, except wheel bearings (1) of all three wheels which are packed with grease *AN-G-E.*

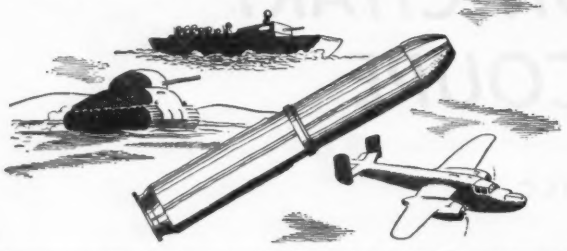
Oiling should be done *every 100 hr.*, except where dusty ground conditions render it advisable to wash with gasoline and relubricate *every 25 hr.*

Shock struts should be filled with Lockheed Hydraulic Brake Fluid *every 100 hr.* (See page 169, Aug. 1944 AVIATION).

A GTD "SHOW-HOW" REPORT

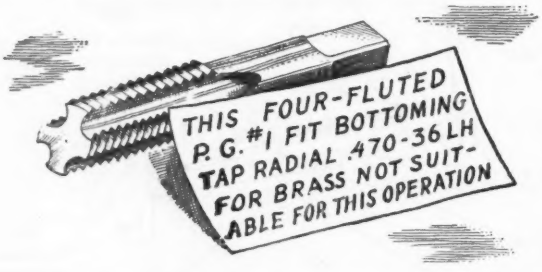
Changing TAP DESIGN SOLVES SERIOUS BOTTLENECK IN 20MM. SHELL PRODUCTION

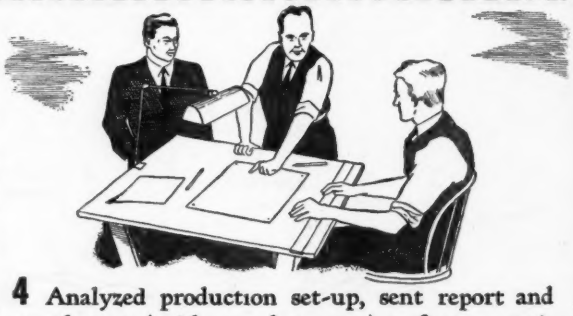
1 Early in U. S. participation in war, brass shortage forced change-over to zinc die castings for body of percussion fuse in 20mm. shell. Demands for this shell were high for use in aircraft, tanks, ships, ground forces.



2 Conversion to material with which this plant was unfamiliar immediately resulted in production difficulties. Taps formerly used with excellent results in brass cut oversize and tore threads in zinc . . . rejects were high, whole shell assembly slowed down.

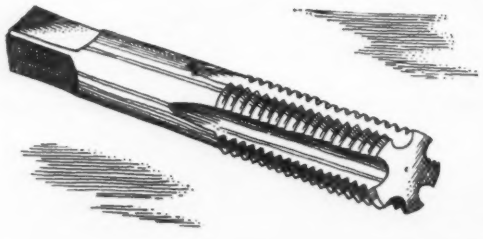
3 Greenfield Field man pointed out that the four-fluted tap with radial cutting face that had been used for brass was not suitable for zinc.

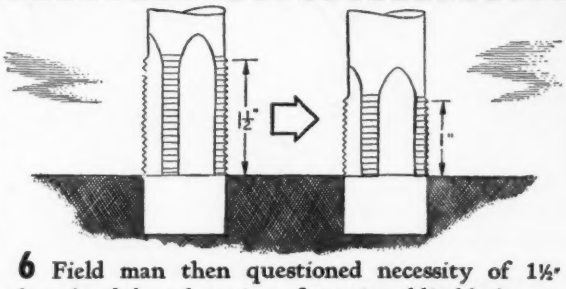




4 Analyzed production set-up, sent report and sample part (with complete specs) to factory engineers suggesting cam face be substituted for radial cutting face to create necessary hook to cut zinc.

5 Factory accepted suggestion, added more . . . engineered a five-fluted commercial ground bottoming tap, which cut well within tolerances *and* . . . cut faster, lasted longer than previous taps in brass.





6 Field man then questioned necessity of 1½" length of thread section of tap since blind hole was less than 1" deep. Tap design was modified to reduce length of thread section, thereby reducing materially time required to make taps, saving money for customer.

Results:

(1) Production of percussion fuse bodies with zinc exceeded best records with brass . . . (2) Costs were lowered . . . (3) As 20mm. shell program expanded, other contractors were saved expensive, bothersome experimenting by fact Greenfield man could SHOW HOW it had been done elsewhere before!

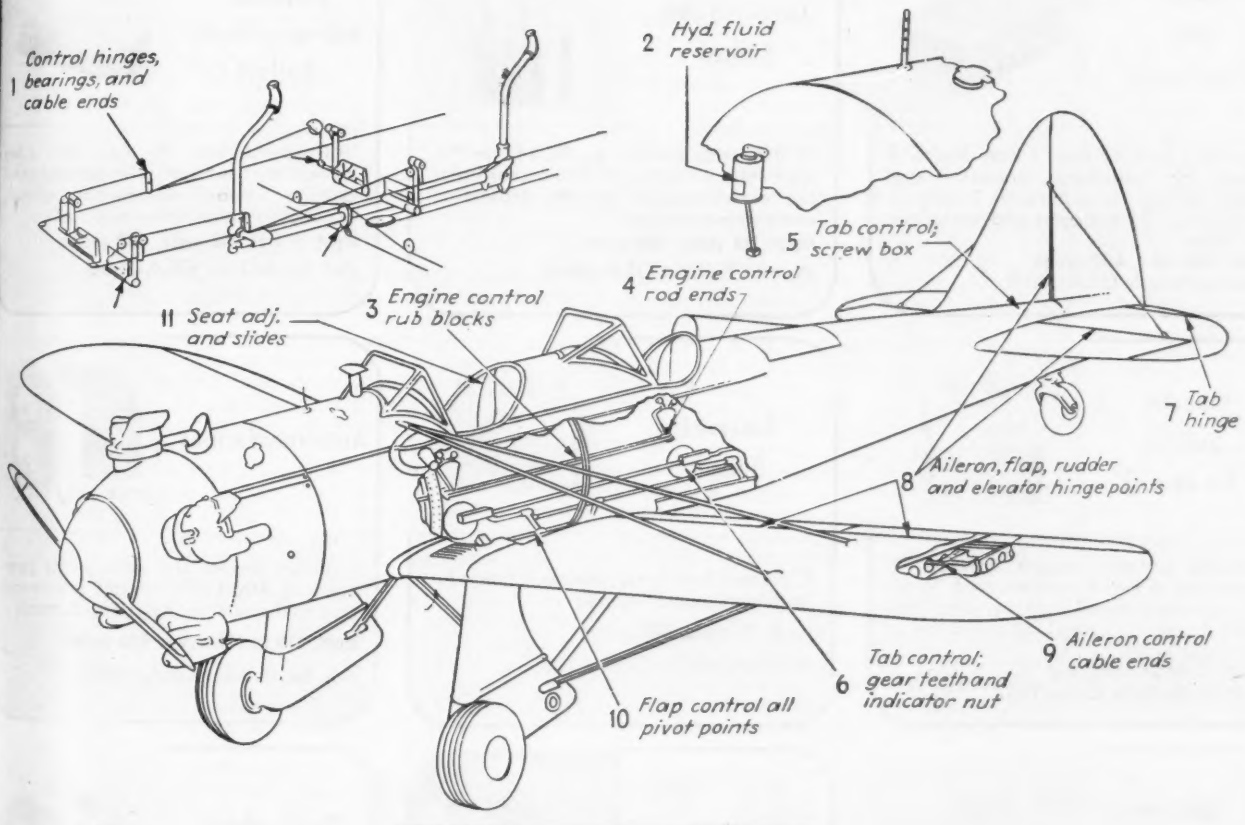
Greenfield SHOW-HOW is KNOW-HOW in action!

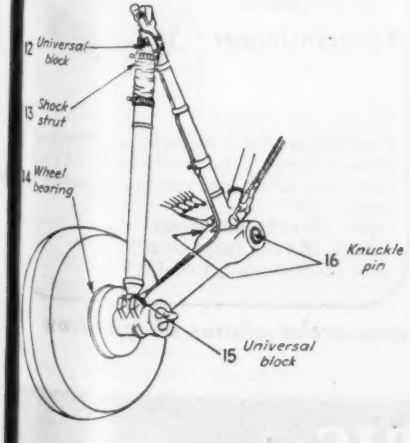
ON THREADING PROBLEMS CALL YOUR GREENFIELD MAN THROUGH YOUR GREENFIELD DISTRIBUTOR!

GREENFIELD TAP and DIE CORPORATION
GREENFIELD • MASSACHUSETTS

AVIATION'S LUBRICATION CHART FOR RYAN

Model: PT-22 Trainer


1 Control hinges, bearings, and cable ends
2 Hyd. fluid reservoir
3 Engine control rub blocks
4 Engine control rod ends
5 Tab control; screw box
6 Tab control; gear teeth and indicator nut
7 Tab hinge
8 Aileron, flap, rudder and elevator hinge points
9 Aileron control cable ends
10 Flap control all pivot points
11 Seat adj. and slides

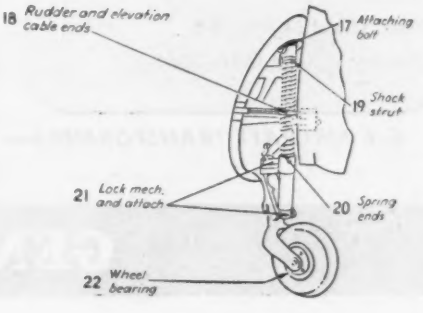


Engine Uses SAE 40 (AN-VV-O-446A, grade 1080) in summer and SAE 30 (AN-VV-O-446A, grade 1065) in winter.

Above grades of oil are used on points (1), (4), (5), (6), (7), (8), (9), (10), (11), (17), (18) and (20) *every 25 hr.*

Soft grease AN-VV-G-681 is applied at (3), (12), (15), (16), and (21) *every 25 hr.*, and AC 3581 (summer) and AC 3560 (winter) greases are used *every 200 hr.* in wheel bearings (14) and (22).

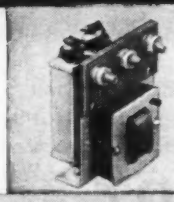
Hydraulic fluid, Mineral base AC 3580 (Stanavo No. 9 or equivalent) or Castor base AC 3586 (Lockheed No. 21 or equivalent) are used *every 25 hr.* at (2), (13), and (19).



QUICK SELECTION CHART OF G-E AIRCRAFT TRANSFORMERS

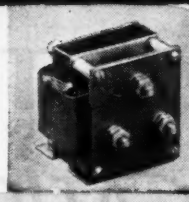
They help combat planes fly higher, faster, farther.
They enable commercial planes to carry more payload.

Single-phase to Three-phase Transformer



Operates one Type KB-1 and one Type KC-1 gyro instrument simultaneously
Input: 115 volts, 400 cycles, single-phase
Output: 115 volts, 400 cycles, three-phase
Ask for Bulletin GEA-4118

Two-phase to Three-phase Transformer



Operates Types KB-1 and KC-1 gyro instruments in aircraft equipped with 750-va Holtzer-Cabot inverter
Input: 26 volts and 115 volts
Output: 115 volts, three-phase, 400 cycles
Ask for Bulletin GEA-4113

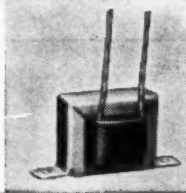
Three-phase to Single-phase Transformer

Provides single-phase power for operation of the radio compass and other instruments and accessories
Input: 115 volts, 400 cycles, three-phase
Output: 115 or 28 volts, 400 cycles, single-phase
Ask for Bulletin GEA-3881

Ballast and Transformer

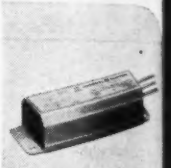
Operates two or four 4-watt MAZDA F lamps for instrument, indicator and panel lighting; also provides 3 volts (5 or 10 amp) for indicator and instrument rim lights
Input: 110 volts, 400 cycles
Ask for Bulletin GEA-3859

Core-and-coil Ballast



Will operate one 4-, 6-, 8-, 15-, or 20-watt MAZDA F lamp for fluorescent lighting of commercial aircraft, depending upon rating selected
Input: 118 volts, 400 cycles
Ask for Bulletin GEA-3860

Enclosed, High-power-factor Ballast

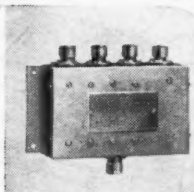


Will operate one 15-, one 20-, or two 30-watt MAZDA F lamps for general cabin lighting aboard commercial aircraft, depending upon rating selected
Input: 117 or 203 volts, 400 cycles
Ask for Bulletin GEA-3866

Inverter Ballast (d-c to a-c)

Provides suitable output voltage for operation of two 4-watt MAZDA F lamps for instrument-panel lighting; also provides 3 volts (1.5 amp) for operation of indicator lights
Input: 12 or 24 volts, d-c
Ask for Bulletin GEA-3907

Enclosed Ballast



Operates four 4-watt MAZDA F lamps for instrument-panel lighting
Input: 26 volts, 400 cycles
Ask for Bulletin GEA-3908

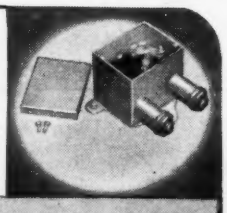
Autotransformer

Furnishes proper a-c voltage for operation of 400-cycle aircraft instruments, such as the remote indicating compass
Input: 110 to 120 volts, 400 cycles
Ask for Bulletin GEA-4260

Ignition Booster Coil (d-c)

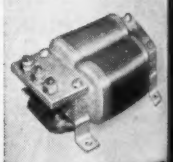
Provides ample and positive spark for starting aircraft engines at low magneto speeds
Input: 12 and 24 volts, d-c
Ask for Bulletin GEA-3861

Starting Vibrator



Provides pulsating, low-voltage current directly to the low-voltage winding of the magneto for instant starting of the engine
Input: 1.8 amperes at 24 volts, d-c
Ask for Bulletin GEA-4105A

Single-phase Autotransformer



Provides proper voltage for operation of 28-volt lamps, electrically heated flying suits, and other low-voltage accessories on aircraft
Input: 120 volts, 400 cycles
Output: 30 volts (open circuit)
Ask for Bulletin GEA-4319

G-E AIRCRAFT TRANSFORMERS—for the war planes of today and the commercial planes of tomorrow

General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

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The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York

Results of International Parley Weighed; Congress Gets CAA'S Master Airport Plan

. . . Light plane "green light" brings applications from manufacturers . . . Poll business-plane field . . . Utility plan offered . . . CPTP reinstatement asked by CAA . . . Details on proposed CAR revisions . . . APB reconstituted.

Nearly everyone has known for years the importance of world air transport. As a result of the 52-nation International Civil Aviation Conference at Chicago, all national leaders and thinkers now know the problems and the efforts that lie between them and the hoped-for international airline system.

Summarizing the maze of written and spoken opinion, that was the most important gain made by the conference. The second gain is an agreement under which signatory nations will accord each other (1) freedom of air passage, and (2) the right to land anywhere for services.

These two of the five freedoms are politico-social. They establish the principle of air right-of-way and haven for aircraft over the entire globe. This right is greater in scope, and broader in social concept than freedom of the seas, which is not under sovereignties.

The other three freedoms favored by the United States are: (3) to fly passengers, mail and cargo from a country of origin to any destinations in the world; (4) to fly such traffic from destinations to country of origin; and (5) to take on and discharge traffic at intermediate points, in many cases competing with the internal aviation of smaller countries.

The first two (3 and 4) imply free competition among all nations; the British want a fixed apportionment of traffic among nations operating airlines, and they would have the Anglo-American share divided 50-50. The last freedom (5) was also opposed by England but favored by the United States delegation, which felt that long air routes could not be operated profitably without trade between intermediate points.

In addition to the gain of worldwide understanding of air transport problems, and partial gain of the first two freedoms, the conference achieved important provisions for the immediate future, and later.

For the present (meaning the war duration and two or three years thereafter) it sets up a 21-man interim council, to be located in Canada. This council is made up of representatives of conference-member countries and has a place held for Russia. The interim agreement will go into effect when it has been accepted by 26 of the conference countries. It is not a treaty and does not require ratification by the United States Senate. It will function until a permanent international air authority is set up, probably several years after the war.

A separate agreement was drawn up, which will give to all countries that sign it mutual rights to the first two freedoms. Another agreement will give to all signers the mutual exercise of all five freedoms. These are for the interim period.

There is also a standard form of bilateral agreement for nations which do not accept the five freedoms, under which they can exchange commercial airline privileges and set up provisional routes.

Supplementary annexes are attached to the conference providing uniform technical practices, landing signals, weather reports, airport facilities, airline maps, codes, certification of pilots and aircraft, etc. Parley delegates were amazed at the volume of technical data available; there was very little controversy over operational matters.

Finally, the conference agreed upon the establishment of a permanent world aviation authority, as soon as possible after the war, to be called the International Civil Aviation Organization. This agreement would be a treaty and would have to be ratified by the U. S. Senate. Much controversy during the five-week meeting hinged on the British proposal that ICAO have economic powers, i.e., to allocate routes and traffic, and to rule on rates and subsidies, whereas the United States, desiring free competition, would limit the organization to advisory and technical functions.

Absence of Russia from the conference was believed due in part to a desire to withhold free passage over the Soviet Union during the reconstruction years ahead. The Soviet government can establish airlines through bilateral agreements, as other countries have done in the past. The way is open for Russia to enter upon interim agreements, or to join

Coming Up

Jan. 8-12: SAE War Engineering-Annual Meeting, Book-Cadillac Hotel, Detroit.

Jan. 24-25: American Meteorological Society, Annual Meeting, Kansas City, Mo.

Jan. 30-31: National Aeronautic Association, Annual Meeting, Brown Palace Hotel, Denver.

Jan. 30-Feb. 1: IAS Thirteenth Annual Meeting, Columbia University, New York City.

Apr. 4-6: SAE National Aeronautic Meeting, Hotel New Yorker, New York City.

Apr. 10-14: ACCA Airplane Technical Committee (10-11) and National Airworthiness Requirements Committee (13-14), New Orleans.

Apr. 26-27: IAS Spring Meeting, Horace H. Rackham Educational Memorial, Detroit.

May 16-19: IAS Joint Meeting with Society For Experimental Stress Analysis, Hotel Statler, Buffalo.

May 20-27: Pan-American Aircraft Exposition, Dallas.

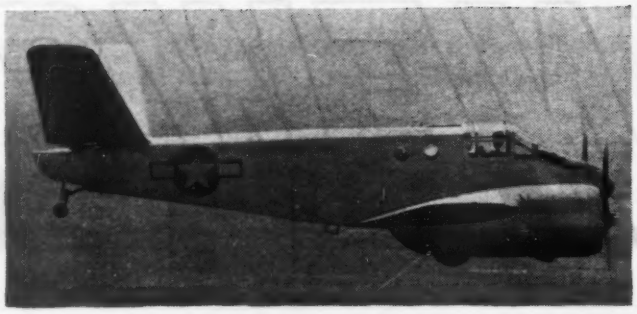
June 4-6. SAE National War Material Meeting, Book-Cadillac Hotel, Detroit.

July (date to be announced): IAS Annual Summer Meeting, Los Angeles.

Oct. (date to be announced): IAS Air Transport Meeting, Washington.

"KEEP 'EM FLYING" CHAMPS

Presentation of Aviation's Maintenance Awards for 1944, which took place at simultaneous ceremonies in Chicago and Memphis. Photo at left shows AVIATION'S Editor L. E. Neville presenting award for airlines operating over 10,000,000 mi. annually to United Air Lines' J. A. Herlihy, v.-p. operations, as W. W. Patterson, president, smiles approval. Photo at right shows T. D. Brooks (left) Chicago & Southern Air Lines maintenance superintendent, accepting award for lines operating up to 10,000,000 mi. from AVIATION'S Managing Editor John Foster in presence of R. L. "Doc" Anderson, superintendent of engineering, and Bruce Braun (right) v.-p. in charge of operations. Twin ceremonies marked 8th presentation of coveted honors.



"BUTTERFLY" BEECH

Feature of Beech Aircraft's modified AT-10—converted for testing new ideas—is unique "butterfly" tail replacing conventional horizontal and vertical empennage surfaces. Company states design offers "possibilities for simplified structure and control." Further aim is investigation of reduction of compressibility effects.

the permanent convention, at any time.

It would be easy to argue that this international meeting was only partially successful. Many critics have done so. But many others in high repute say that just putting all the cards face up was well worth the effort. Every nation gave ground, and most gained something of what they had wanted. Praise for Adolph Berle, resigning assistant Secretary of State and chairman of the American delegation, was almost unanimous.

Congress Gets CAA's Airport Plan

After months of preparation, and after lengthy consideration by the Bureau of the Budget, the Civil Aeronautics Administration's Master Airport Plan has been submitted to Congress. It calls for appropriation of $1,251,567,945 to be disbursed during the next 5 to 10 yr. in matching State funds, for construction of 3,050 new airports, and improvements to 1,628 fields to make nation's total 6,305.

CAA asks $1,021,567,945 for clearing, grading, paving, lighting, and radio, and $230,000,000 for land and buildings other than hangars. Appropriation of $3,000,000 is called for immediately to cover surveys and preparatory work. The report suggests amounts to be appropriated for each State; it subdivides all the amounts for improvements and new construction, but does not mention locations.

It is recommended that the number of Class 1 fields, mostly for private flying be increased from 981 to 2,597; Class 2 fields, from 810 to 2,198; Class 3, from 443 to 654; Class 4, from 403 to 520; and Class 5, for long-range operations, 305 to 336.

The National Aeronautic Assn. has a tabulation of proposed appropriations, and number of new projects and improvements, by Class, for each State.

T. P. Wright, CAA Administrator, stated in a recent address that the airport program meets all the criteria for useful public works. The Budget Bureau, Treasury watchdog, scrutinized the necessity of such large expenditures for the direct benefit of a small minority of citizens. The Federal Works Agency recently made a survey of proposed public works, and it implied in its findings that the need for doubling the airport system was questionable.

CAA's Master Airport Plan will be converted into the form of a bill to come before congress. The Federal Aid Airport Act, already proposed by Rep. Jennings Randolph (W. Va.), aviation leader in the House, closely parallels provisions of the Master Plan, and with some revision it could become the Administration's airport proposal. It is expected that hearings will be held on the Randolph measure, or a similar one, early in the year.

Light Plane "Green Light" Brings Applications

Production of light civilian airplanes is expected to begin very soon. Each project must be specially authorized by the WPB's reorganized aircraft division. Each manufacturer must show that he has (1) essential orders; (2) available non-critical materials; and (3) non-critical manpower.

Output will be definitely limited for a while. According to WPB's ruling, production will be stepped up with the collapse of Germany. Approval by WPB means that Army, Navy, the War Manpower Commission, and other agencies concerned, have agreed.

Several applications have been filed by Piper, Ercoupe, Beech, and others. Ercoupe's application was temporarily rejected because its location in Maryland (near The Glenn Martin Company) placed it in a critical manpower area. Grumman was the first to receive authorization, to produce 20 units.

The go-ahead on light plane production was delayed by the Army's sudden demand for an increased backlog of ammunition and other war supplies.

Poll Business-Plane Field

The light plane industry again hopes, as it did in the boom of the late '20's, that business, industry, and professional men will include airplanes among their equipment.

Latest effort to forecast this trend comes from the Automotive & Aviation Parts Manufacturers, Detroit. Of 145 member companies answering a questionnaire, 31 indicated interest in owning or leasing a plane for executive use after the war; eight said they definitely would buy. Only nine are using privately owned planes for business now; most want two-engined planes.

Utility Plan Offered

A five-point program necessary to bring about improved utility in personal aviation was offered by John E. P. Morgan, manager of ACCA's Personal Aircraft Council, speaking at the National Aviation Clinic, Oklahoma City.

Proposed are (1) landing facilities for every community; (2) installation of simple airmarker systems throughout the country; (3) competitive development of better and safer airplanes; (4) revision of Civil Air Regulations and their uniform enforcement by State authorities; and (5) education of the public in proper use of planes and facilities to the best advantage.

CPTP Reinstatement Asked by CAA

Reinstatement of the CPTP, with benefits extending to a vast number of American youths, has been recommended to Congress by the CAA. Dr. Bruce Uthus heads its new training division.

The recommendation calls upon the government to appropriate funds to be matched in the ratio of 3 to 1 with local governments (state, county, municipality) or with educational institutions. The training would be given almost entirely by schools and colleges. Local governments and the schools would determine the amount of reimbursement they would require of students, if any.

Primary objectives of CAA in its proposed program would be to create a large flying population for military security, and to support the growth of the aircraft manufacturing industry. To build a large flight student body, it would be necessary to set physical standards far below those of the Army and Navy, which are very exclusive in peacetime.

Details on Proposed CAR Revisions

In sending out, for further comment, its revised drafts of Parts 20, 43, and 60 of the Civil Air Regulations, CAB's Safety Bureau is noted to be considering desirability of less restrictive weather minimums. All weather restrictions have been removed on flights below 1,000 ft. when the visibility is not below 1 mi., except in controlled zones where considerable airline traffic is to be encountered.

Spins have been eliminated in the flight test required of private pilots, but they are included in the instruction required before applying for the flight test for a private pilot certificate. The experience required for instrument flying has been increased from 20 to 40 hr. because experience has shown that the time formerly required was inadequate.

Part 43 has been revised so that a pilot need not log all his flying time and so that flight time and engine time are kept by means of the usual log or an approved mechanical device similar to the speedometer on an automobile.

APB Reconstituted

WPB Chairman Krug has announced membership of the reconstituted Aircraft Production Board. Mr. Krug is APB chairman, and with him are:

Gen. William S. Knudsen, director AAFATSC; Maj. Gen. O. P. Echols, Asst. Chief, AAF Air Staff for Materiel and Services; Rear Adm. Lawrence Richardson, Asst. Chief Navy Bureau of Aeronautics; T. P. Wright, CAA Administrator; and Myron A. Tracy, Acting Director ARCO.

SPOT CHECKING

Navy makes known its addition of new Curtiss SC-1 Seahawk. Presumably it will supplement Vought Kingfisher.

First reported action of new Douglas A-26 Invader attack-bomber was by 9th Air Force supporting Third Army drive into Saar.

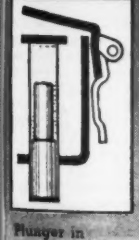
New plastic-bonded hangar for large single-engined planes has been developed, having 44½-ft. door width, 30-ft. depth, and 11-ft. clearance. Structure is of douglas fir plywood over yellow pine frame, and three veneers, employing plastic adhesives, are described as waterproof, warp-proof, and repellent to insects and dry rot. "T-44" is designation of hangar, which is made by Texas Pre-Fabricated Housing Co., Dallas.

CAA is now testing VHF (Very High Frequency) radio ranges, which will register bearing of

QUICKER THAN YOU CAN READ THIS HEADING

The Operator has sealed another TIME-DELAY TUBE for a

HEINEMANN
MAGNETIC CIRCUIT BREAKER



Plunger in normal position at bottom of cylinder.

Plunger after overload with armature attracted to pole piece, opening contacts.

Every time-delay type HEINEMANN Circuit Breaker is equipped with a time-delay tube. This operates so that the contacts open with a speed in inverse ratio to the amount of overload current passing through the breaker coil which surrounds the tube. The time-delay prevents the breaker from opening on sudden inrush currents, but allows it to open on sustained overloads. The plunger action in the liquid-filled tube shown at the left is the secret of how this is accomplished. The speed with which the plunger is drawn toward the pole piece depends on the viscosity of the liquid.

By means of a special apparatus developed by this company, the operator hermetically seals the time-delay tube in ONE SECOND by melting and spreading a drop of solder over the end cap of the tube. This is done by thrusting it into the field of a high-frequency induced current.

Speed is necessary, since the tube is entirely filled with a liquid which would boil and explode the tube if the heat lasted too long.

Send For Catalog Showing Complete Line and Engineering Data

HEINEMANN CIRCUIT BREAKER CO.

Subsidiary of Heinemann Electric Co., Est. 1888

115 PLUM STREET TRENTON N. J.

Every day—

THREE MILLION MILES

...That is the war-winning record of the Air Transport Command, Naval Air Transport Service and Troop Carrier Command

— They, too, depend on Douglas

First AROUND THE WORLD · *First* THE WORLD OVER

Douglas AIRCRAFT

The ATC flies men, munitions and medical supplies over 160,000 miles of air routes to every battle front in the world.

The NATS links every ship of our Navy directly with our country, flying 75,000 route miles.

The TCC carries our paratroops into battle, tows gliders filled with men and equipment, rushes supplies to the fronts and evacuates all of our sick and wounded.

Like our domestic airlines, which are contributing importantly to this task, these three services are more than 80% Douglas equipped.

lane on cockpit instrument. Distance range is 50 mi. at 1,000 ft., increasing to 100 mi. at 10,000 ft. Voice may be carried as well as course signals, and static-freedom is feature.

UAL recently chalked up its 1,000 trans-Pacific flight for ATC.

Union Oil Co. of Calif., through its Aviation Department, has launched a series of "Postwar Aviation Opportunities" advertisements directed to air force personnel. Copy, in bulletin form, gives data on various potential peacetime aviation jobs.

Doubling as a dive-bomber, the Vought Corsair has been carrying explosive loads up to 2,000 lb. — twin thousand-pounders slung under the fuselage.

"Night eyes" of the Northrop Black Widow, operating in both war theaters, are stated to comprise a "binocular installation, electrically operated, and which swings into place aft of the pilot's armor glass."

Value of house organs in aircraft plants is reflected by poll taken by Canada's Aircraft Industry Relations Committee. Answers to questionnaire circulated in 12 plants indicated that 97 percent of all aircraft employees read most of the items in their plant magazines, with 91 percent saying they find such publications create better understanding, and 88 percent declaring this medium is helpful for explaining company policies and regulations.

Quiz by Bellanca regarding type of peacetime plane desired indicates majority want single-engine three- or four-place land plane with 140 mph. top speed, 125 mph. cruising speed, and 500-mi. cruising range. Low-wing with retractable gear appears favored. More than third of quiz participants have been men in armed services.

Working model of a jet-propelled helicopter has been made at Georgia Tech, and head of university's school of aeronautics, Prof. Donnell W. Dutton, declares experiments with it show full-size plane of type would be feasible. Jet of air, drawn through nose duct system by high-speed axial blower, passes through rotor hub and into hollow rotor blades, then is discharged from blade tips.

One model of the British Mosquito has been fitted with a six-pounder nose cannon for attacks on German submarines and shipping.

It is revealed that New Zealand's new Pacific Air Task Force has now gone into operation against the Japanese, presumably from New Guinea bases.

Department of Aviation, under College of Applied Science, will be opened at Ohio University, and major in aeronautical engineering will be offered.

Neat, indeed, was Aeronca Aircraft's answer to Wesley Price's article, "I'll Get in My Little Plane and—Zip!" appearing in "The Saturday Evening Post." Price's boldly painted apprehensions of personal-plane difficulties were pointedly burlesqued by Aeronca in an article titled, "I'll Leap in My Little Auto and—Zam!" done up with same layout as "Post" feature. Paralleling Mr. Price, Aeronca's author (a "Wilfred Spruce") a sour 1915 view of future of automobiling. The two articles comprise an Aeronca mailing piece which is a very good tonic for future-worriers.

Beech Aircraft, in conjunction with International Assn. of Machinists (AFL) and Dymaxion Dwelling Machines, reports completion of plans for mass production of "dwelling machines," new type of housing which it is stated will utilize aircraft technology, materials, and tooling. Possible use of these pre-fab units in Pacific campaign is remarked.

AMERICA AT WAR

Aviation's Communique No. 37

Formation of the new 21st Bomber Command under the 20 Air Force, along with B-29 operations against Jap steel and aircraft works from American bases in the Marianas, marks the true beginning of the real strategic air attack on Japan.

But it is only the beginning. The round trip is over 3,000 mi., and the weight of fuel necessarily still lessens the loads of explosives and incendiaries. These missions are a grueling experience for the crews; weather is tough; and maintenance and supply remains an enormous task. Considering the weight of air attack on Germany, and the Germans' ability to take it, the obvious conclusion is that, if the Japs are just as tough, they cannot be seriously hurt till they receive comparable bombardment.

This beginning, however, will rapidly swing into full-force operations. Since gasoline is delivered direct from tankers at the Marianas to planes of the 21st., a fuel limitation is not suffered like that of the 20th, whose supply is still mostly flown over the Hump. Meantime, the Army's call for more Superfortresses is being strongly backed up by the home front. Missions of 100 bombers will be boosted to several hundred.

From their new positions in the Philippines, Army and Navy have air control of the entire China Sea area. Their next forward move, probably into the Bonin and Volcano Islands, will not only greatly increase the "pay" load of the B-29's (by reducing the distance to 600 or 700 mi. but it will also bring the B-17's and B-24's within range of Japan. Bombing missions then will be accompanied by the Lightning, Mustang, and Thunderbolt fighters. The Lightnings have already been there, from whence is not told.

When Navy task forces can get close enough, their ship-based fighters also can cover the Army's bombers and can attack ground objectives direct. The Navy soon will be able to concentrate flights of 2,000 or more warplanes when necessary.

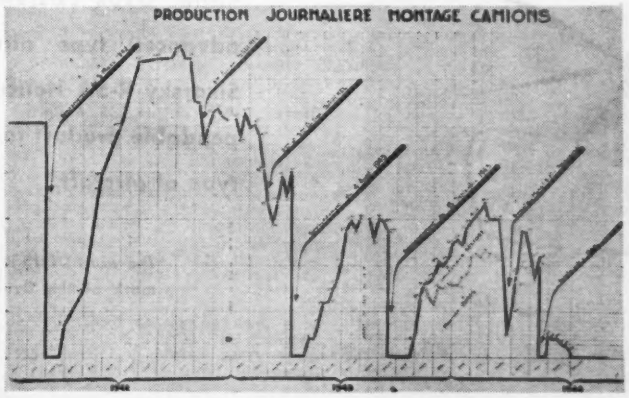
The 20th Bomber Command, organized with the 20th Air Force, of course continues to operate from China and India, under great supply difficulties. However, the international news experts still predict that Russia will grant the Allies the use of bases lying less than 700 mi. from Jap objectives.

While the Mikado's army aviation grows stronger by replacing its losses, by improving power and design, and by concentration as it backs up toward home, Vice Adm. Marc A. Mitscher, commander of the Third Fleet's carrier forces, states that Japan's naval aviation has been virtually wiped out. All of her original carrier fleet has been sunk; the amount of replacement is unknown, but it is ineffectual.

The Naval battles for the Philippines rubbed out Japan as a major sea power, which can not again take on a major pitched battle; but it can inflict damage in opposing the advance of American forces. Most of the sunk Jap warships were slugged by American surface ships, which gave rise to a new flurry of talk on an old subject: Air vs. sea power.

In Europe, Allied air forces are setting new records in number of sorties flown and in weight of bombs dropped. Air power advocates are increasingly surprised at the amount of demolition a first class military power like Germany can take and retain strength. The reduced Luftwaffe took quite a part in the recent German counter push; underground and dispersed production of fighters probably will continue near its present rate.

In three years of war, Army Air Forces have flown more than 1,500,000 combat sorties; dropped more than 1,000,000 tons of bombs; and destroyed 30,000 enemy planes. These data were released by the War Department in a Pearl Harbor day summary. American losses were put at less than 14,000, below half that of the enemy with roughly 8,000 shot down in combat, less than 300 destroyed on the ground, and 5,000 brought down by A-A fire. Eighty-five percent of bomb tonnage was dropped on Europe. Berlin received 14,000 tons, more than any other target.



HOW BOMBERS CURBED TRUCK PRODUCTION

AAF officers were able to gage effect of Allied bombings of a large enemy plant when liberation of Paris turned up this "production journal" graph of Renault Billancourt factory. Vertical axis (left) shows that 51-truck output in early '42 went down to zero for nearly full month after RAF's Mar. 3 bombing, and results of subsequent U. S. air attacks in '43 and '44 are depicted. In May '44, aerial attacks on communications reduced supply of coal for generating electricity, then invasion brought full shutdown. (International News photo.)

★ CANADIAN NOTES ★

By James Montagnes

Canadair, Ltd., new company formed from aircraft division of Canadian Vickers, Ltd., Montreal, is now building Douglas DC-4 transports for the Canadian government, using a plant at St. Laurent, just outside Montreal. Benjamin W. Franklin is manager.

A Dominion-built Mosquito recently flew the 2,300 mi. from Goose Bay, Labrador, to Prestwick, Scotland, in 6 hr. 8 min., breaking all previous trans-Atlantic flight records. Capt. E. M. Gill, RAFTC, was pilot.

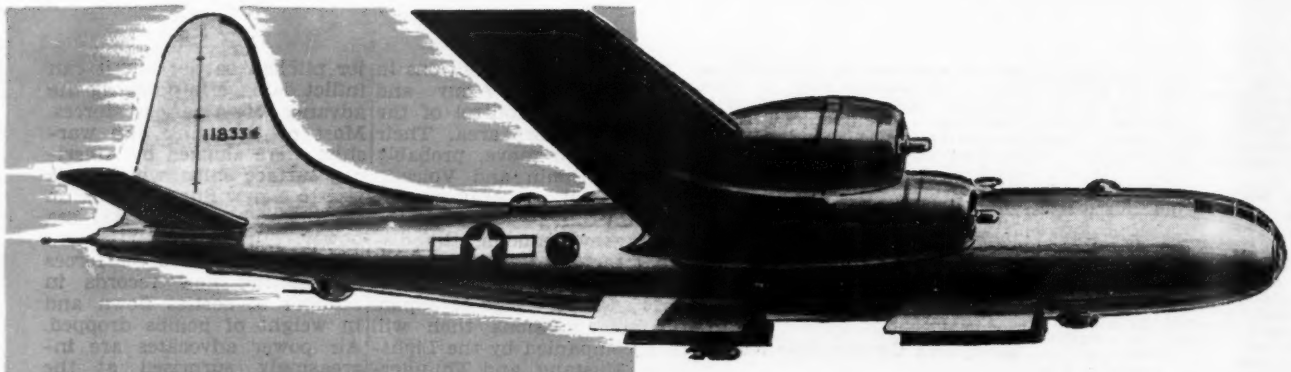
Trans-Canada Air Lines is reported about to add a third daily transcontinental flight to its services between St. John's, Newfoundland, and Victoria, B. C. TCA also plans to step up from three to four the daily round-trips between Toronto and New York.

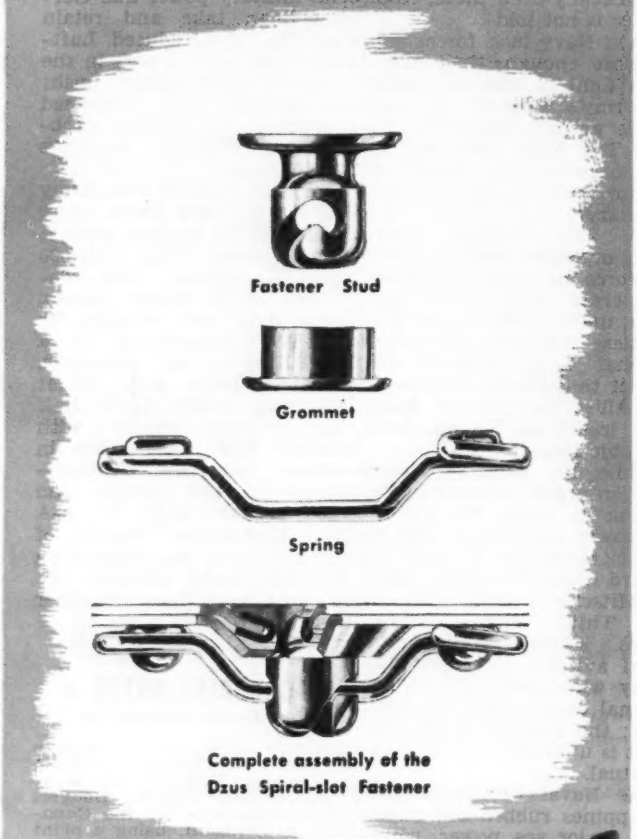
Canada should develop a new aerial workhorse for the northland, rather than compete with the world aircraft industry, declares W. J. McDonough, managing director of Central Aircraft, Ltd., London, Ont.

OBITUARY

Col. John A. Paegelow, retired, ex-commandant of Scott Field, Ill., and authority on lighter-than-air craft. In 1926-27 he directed flights of semi-rigid dirigible RS-1.

Joseph Vaccaro, formerly v.-p.





DZUS*
KEEPS PACE

In the early days of aviation the Dzus Spiral-slot Fastener was developed to fill a vital need for a dependable fastener. Through the years this fastener kept pace with the ever-increasing demands of a fast-growing industry. Today—Dzus dependability is proved by the different types of aircraft where the Dzus Fastener is installed. For example: Dzus Fasteners are used on the Boeing B-29 Superfortress—the plane that carries the heaviest bomb load the farthest. On the other hand, Dzus Fasteners are found on advanced type aircraft, such as the Sikorsky R-5A Helicopter. It takes a dependable product to be chosen for every type of aircraft.

*The word DZUS is the registered trade mark of the Dzus Fastener Co., Inc.

DZUS TRADE MARK
FASTENER CO., INC.
BABYLON NEW YORK
In Canada—Railway and Power Engineering Corp. Ltd.

of Coast. Airways and senior instructor at Republic Aviation's P-47 Thunderbolt school.

Charles S. J. MacNeil, chief engineer, Aeroproducts Div., General Motors Corp., and co-inventor of Aeroproducts automatic constant-speed propeller.

Sven R. Bergman, General Electric Co. specialist concerned with aircraft electrical generating equipment.

Comdr. Willis B. Haviland, who in 1918 accomplished an airplane takeoff from a battleship deck, and was decorated by the United States, France, Britain, and Italy. During World War I he served in the Lafayette Escadrille.

William R. McPhail, assistant to Atlantic Div. traffic manager, Pan American Airways.

Carl A. Cover, v.-p. Bell Aircraft Corp., and former Douglas test pilot.

Max Stupar, who had been chief industrial planner, Bell Aircraft Corp.

William Knight, inspection-methods engineer, Curtiss-Wright's propellor Div., Caldwell, N. J.

O. J. Gude, Jr., who had been v.-p. of General Airways System.

★ CALLING NAMES ★

Changes in Aeronautical Chamber of Commerce posts: **Donald W. Douglas,** pres. of Douglas Aircraft, becomes new chairman of board of governors, with **Lawrence D. Bell,** pres. of Bell Aircraft, and **La Motte Cohu,** Northrop chairman, becoming members of board. **Eugene E. Wilson,** United Aircraft vice-chairman, assumes presidency of chamber. **Scott Russell** has resigned as general manager, because of ill health and **Donald B. Cooper** has been appointed readjustment service staff assistant.

Awards: **Richard C. du Pont,** posthumously given Evans Glider Trophy for greatest individual contribution to glider development in '43; **Carl L. Norden,** Holley Medal for 1944, for bombsight and automatic pilot inventions; **George W. Lewis,** aeronautics authority, Spirit of St. Louis Medal, and Junior Award of same medal to CW engineer **Martin Goland Jr.; Dr. Edgar Fuller,** asst. dir. CAA aviation education program, Frank G. Brewer Trophy for 1944 for contribution to education of American youth; **Roy W. Howard,** pres. of Scripps-Howard newspapers, Hawks Memorial Award; **Lawrence D. Bell,** pres. of Bell Aircraft, Daniel Guggenheim Medal for 1944 achievement in aeronautics; and **Maj. C. C. Moseley,** pres. of Polaris Flight Academy, joint USAAF and RAF Certificate of Service Award for training aviation cadets.

Charles A. Wight, v.-p. of Banker's Trust Co., is new Grumman Aircraft director, succeeding **B. Allison Gillies,** resigned.

Palmer A. Hewlett becomes Convair's export sales director with **Harvey C. Tafe,** San Diego service director succeeding him as Washington representative, and **O. E. Mecham** stepping up to service director. Reorganization of engineering activities at San Diego brings design, research, and development under **I. M. Laddon,** executive v.-p. while administration of engineering and flight research goes to **B. W. Sheahan,** engineering manager. **James C. Welsch** becomes private sales director for company's Stinson div. at Wayne, Mich. At Convair's Miami Div., **J. R. Harrison** takes on as ass't. factory supt.; **J. Zimmerman** as supt. of salvage; and **Bertram H. Osgood** as supervisor of plant layout section. At Fort Worth, **C. J. Hanley** becomes supt. of salvage; **Paul Mitchell,** ass't. chief tool engineer; and **Frank J. Heidemann,** night factory supt. At Allentown Div., **Gavin Alexander, Jr.,** has been named purchasing agent; **Vernon E. Groves,** chief of flight; and **Galen P. Potter,** ass't. supt. of field operations. At New Orleans Div., **James H. Whitaker** becomes general supervisor of industrial engineering.

Christopher de Groot, formerly Panagra U. S. sales representative becomes general traffic mgr. to head traffic and sales activities in both Americas; **Raymond E. Montgomery** takes over as line's special representative in Miami; **Richard W. Sylvester** is appointed traffic manager, and **Harmon A. Harris,** public relations and advertising mgr., for South America, with hq. at Lima.

L. B. Kinports becomes mgr. of UAL's foreign agency and tour dept. with hq. at Chicago. New positions in western area are filled by **S. O. Halberg** as company's district traffic mgr. at San Francisco, being succeeded in similar capacity at Salt Lake City by **Sam B. Kellogg,** while **Carl Murray** becomes asst. district traffic mgr. in addition to mercantile representative at Los Angeles. **Hobart Hartong becomes** asst. supt. of maintenance, and **John E. Grabow** mgr. of disbursements, at UAL's Chicago hq. **Gordon Wood** is made ass't gen. purchasing agent at Cheyenne base, and is succeeded as shop auditor by **W. J. Kiefer. Comdr. W. Larned,** chief staff officer, NATS, and former company pilot, has received letter of commendation for meritorious service from Secretary of Navy.

Robert A. Gaffney is appointed associate director of labor relations for Bell Aircraft, with hq. at Buffalo.

G. B. Barlow is appointed comptroller of Douglas' El Segundo plant.

D. C. Evans has been named supt. of stations for Northwest Airlines' eastern region between Chicago and Billings, Mont., with hq. at Wold-Chamberlain Field, Twin Cities Airport.

Jacqueline Cochran (Mrs. Floyd B. Odlum) has been elected to Northeast Airlines' board of directors.

Charles L. Gallo, TWA traffic expert has been granted leave of absence to become gen. mgr. of TACA Central American Div. **F. B. Eisenberg,** ass't. to company treasurer, has been named director of purchasing and stores. **John M. Lockhart,** sec. and treas., and **Don R. Eldridge,** operations staff supt., have been granted temporary leaves for special assignment.

Dr. Jerome C. Hunsaker, pres. of MIT, and **Dr. W. F. Durand,** Stanford U., have been reappointed by President Roosevelt to serve for additional term of five years as members of NACA.

Glen D. Woodmansee has been designated acting general counsel of CAA, following resignation of general counsel **Webb Shadle.**

Robert M. Hatfield, Jr. is named engine parts control special ass't. to **Harold Boeschenstein,** operations vice chairman of WPB.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Zero day in Russia's policy toward Japan will be Apr. 25, 1945. If non-aggression pact between them is not denounced by that day, it will run for another five years. Opinion here is that the Soviet, following the "aggressor" charge tossed by Stalin at Nippon weeks ago, will scrap the treaty; further, that the Reds will not only give bases to the Allies, but will join in the mop-up activities.

CAB and CAA are still trying to explain their intricate relationship—how they are separate entities yet together comprise the Civil Aeronautics Authority. By the time most people understand it, Congress probably will change it again—and plenty of folks are working toward that end, as usual.

Chicago conference gave all its time to scheduled international air transport. Who can be sure that, in the far future, private aviation may not be just as international? CAB's hearings, Feb. 12, will give you or anybody a chance to talk on that subject.

No more fighters, with conventional gasoline engines will be designed—at least this was the opinion expressed by Lt. Gen. Barton K. Yount, chief of Army air training, in one sentence of his speech at Oklahoma City. This means he believes new fighter designs will incorporate jet-turbine power plants.

Quiet, please! The airpark and close-in airport people, working diligently for private flying, realize they are up against a real problem in airplane noise. Somehow the buzz-sawing of propellers has to be modified, or in-town airport location will be seriously handicapped.

The Stubblefield Award goes to the Navy for not having a name for its aviation. It would be a mistake to call it the Bureau of Aeronautics, even if anyone wanted to.

Leslie Craven has been retained to represent CAL in forthcoming applications for new routes. **Jack Black,** company's former flight control office dispatch clerk in Denver has been appointed chief operations agent in Kansas City, replacing **Kenneth Borgmier** who has been transferred to San Antonio to become CAL's first chief operations agent there.

John Sherman has been appointed liaison consultant to CAB, filling position vacated by **Howard B. Railey** who has been named civil air attache to American embassy in Paris.

Perley Boone is appointed director of press for Air Transport Association, with hq. in Washington.

William McK. Reber, Jr. is made director of aeronautics, State Aviation Commission of Maryland.

New assignments in sales dept. of Bendix Aviation, Pacific Div. includes **Donald T. Boody** as liaison engineer for aircraft plants on west coast; **William P. Harrison** as midwestern representative for hydraulic and electrical equipment, with hq. in St. Louis; and **Edward M. Nash** in charge of hydraulic equipment items.

Vernon W. Payne is now serving as chief engineer of Robertson Aircraft Corp.

Verner D. Vale is new technical director of Embry-Riddle School of Aviation.

A. T. Lundgren, formerly engineer with Vega and Lockheed, is affiliated with Conners-Joyce Associates as chief engineer, technical div.

Ralph Howlett is made chief accountant of TACA in Central America, with hq in Tegucigalpa, Honduras.

Tom O. Duggan, v.-p. of Thompson Products, has been elected pres. of Aviation Distributors & Manufacturers Assn., and **Sydney Nesbitt,** sales mgr. of Lear's aviation radio dept., is chosen as a director.

Robert E. Ringle, former chief of planning with Bell Aircraft experimental div., recently joined Scott Aviation Corp. as field engineer.

Guy H. Harper is new president of Columbia Aircraft Industries, succeeding **J. S. J. Hlobil,** resigned.

Racy D. Bennett has resigned as mgr. Vinco Corp's hydraulic div. to establish office as consulting engineer in Calif.

Aviation Manufacturing

Call for Doubling of Superfortress Output; Labor and Production Problems Encountered

. . . November unit output of airplanes was a low 6,747 . . . We made 223,500 in 3 yr.; Britain 102,000 in 5 . . . Rocket ammunition outlay to pass $100,000,000. . . . "Keep on with engineering and research" says Echols . . . Tax law change sought to aid cutback firms.

Unqualified success of B-29 operations in the Orient has resulted in an urgent call from the Army Air Forces to workers and managements everywhere, feeding the Boeing Superfortress program, to give it everything they've got. Call is in for the U.S. to double its production of these big craft.

Air Service Technical Command, addressing an appeal to the press quoted Lt. Gen. William S. Knudsen, its director, as terming such aircraft the "quickest and best means to smash Japan." The ASTC letter said "Recent strikes and production difficulties have not, of course, improved the situation."

A high War Department authority recently told AVIATION representatives that the Wichita and Omaha plants were on schedule, that the Atlanta plant was slightly off, and that the Boeing home plant at Seattle, which is past midway in conversion from B-17's to B-29's, was being hindered by the changeover and by labor and manpower difficulties. He said that the Boeing conversion—being accomplished while large numbers of B-17's continue in production and B-29 output increases—is everywhere regarded as a notably engineering achievement.

In announcing November production, WPB Chairman J. A. Krug said that Superfortress output did exceed the schedule for that month by a small margin. But he added that not enough of these craft were being made to meet the Army's plan of attack in the Pacific.

The Air Forces' references to strikes undoubtedly included stoppages participated in by 10,000 members of the UAW-CIO union at Superfortress departments of Dodge, Briggs Mfg. Co., the Mack plant, and Graham-Paige.

After an inspection trip, Gen. Knudsen said aircraft production, particularly that of B-29's, was "not good enough" because of high absenteeism and unnecessary resignations. Knudsen asked that B-29 output be doubled within three months.

Boeing Plant No. 2 at Seattle will produce major sub-assemblies, such as wings, tail sections, and fuselage sections. These will be trucked to the near-by Renton plant for final assembly. Officials believe this arrangement will result in doubling the rate of production. Boeing of Canada is producing B-29 parts which are shipped to Seattle.

The Superfortress program, involving thousands of tributary plants throughout the country, is by far the biggest aircraft enterprise in history Meantime, B-17 Flying Fortresses, needed for the final knock-down of Germany, continue in production at the California plants of Douglas and Lockheed.

November Plane Output Was a Low 6,747

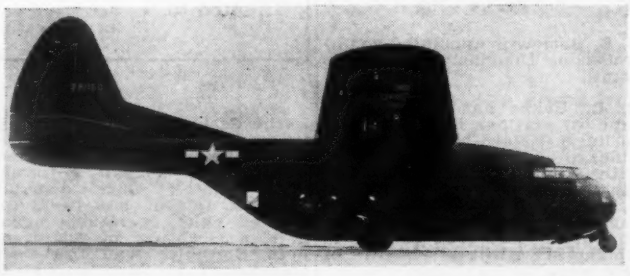
Unit aircraft production in November, announced WPB, was 6,747, as compared with a schedule for the month of over 7,000. Chairman J. A. Krug explained that failure to meet the quota was due to design changes and to the Thanksgiving holiday interruptions.

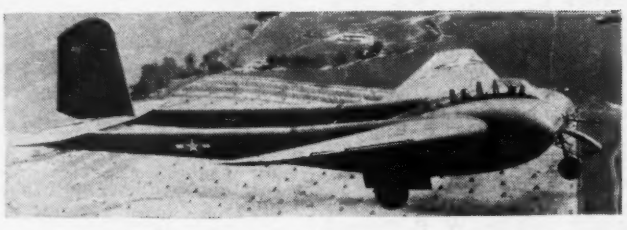
Accordingly, November output was the lowest in units since the production of 6,471 in Apr. 1943, a year and a half ago. The continuing unit decline, since the high point of 9,118 in March this year, is due both to increasing unit weight and to cutbacks on types no longer needed and types in full supply. Production in October was 7,429, September 7,598, August 7,939, July 8,000, June, 8,049, May 8,902, and April 8,343.

Mr. Krug said that the output of four-engine long-range transports was particularly disappointing in November. He stated three types of Navy shipboard planes, a torpedo bomber and two patrol planes, missed the schedules by wide margins. This is serious because the schedules on these three types are to be increased shortly.

For the first time since last April, when the unit output begin to decline, the situation is causing apprehension. Over-optimism of the public on war progress is an increasingly important factor in the lagging aircraft program.

Among requests for supplementary war appropriations for the current fiscal year, Navy calls for the largest item —$336,617,954. At the same time, however, the Bureau of Aeronautics, as reported by the Budget Bureau, proposes cancellation of $2,000,000,000 in contract authorizations. The cut is made possible by downward revision of previously established requirements. The authorization for naval aviation in 1945 appropriation act was $3,600,000,000.





NEW ENGINE-LESS SKY-FREIGHTERS

Two huge new gliders—the XCG-10A Trojan Horse (top) and the XCG-16 (above)—are revealed by ATSC to be 6-ton and 5-ton carriers, respectively. Design of 10A was provided by Laister-Kauffmann Aircraft Corp. of St. Louis, while the 16, constructed by General Airborne Transport of Los Angeles, stems from a Hawley Bowlus design. Both craft employ tricycle gear and are of laminated plywood construction but they are otherwise dissimilar. Span of Trojan Horse is 105 ft. and length 67 ft.; and XCG-16's span is 91 ft. 9 in. and length 48 ft. 3 in. Former has cargo compartment nearly 30 ft. long, while latter features twin cargo sections, each 15 ft. long.

We Made 223,500 in 3 Yr.; Britain 102,000 in 5

America's total unit production of aircraft for 1942, '43, and '44—the three calendar years following Pearl Harbor hit a figure of 223,500 (that is, guessing a rough 6,750 for last month). And with the 19,290 planes made in '41, we have a round-number total of 242,800. Output in '42 was 47,873; for '43 it was 85,945; and through November of '44 it was 82,926.

Relative English performance is offered in figures appearing in the recent British White Paper summing up five years of war production. In that time the United Kingdom built 102,000 planes and, among other equipment, 25,000 tanks, while suffering almost 700,000 civilian and military casualties.

The aircraft plants, operating under blackout conditions and frequently under actual attack, turned out 10,018 heavy bombers (included in above total). Another figure gave 940 as the current monthly production of fighters.

Rocket Ammunition Outlay To Pass $100,000,000

Early in 1945 Navy expects to reach a $100,000,000 monthly expenditure for rocket ammunition—as much as is now spent for all types of naval ammunition. And the army, which spent about $1,000,000 for rockets in 1942, believes it will spend about $12,000,000 per month in 1945. These expenditures will be in addition to outlays for launching tubes and facilities.

A large portion of the anticipated rocket war will be carried on by aircraft. OWI, which made the report, says that rockets are fired from Lightnings, Airacobras, Thunderbolts, Mustangs, and Bell jet Airacomets. Navy has been launching them from its Avenger torpedo plane.

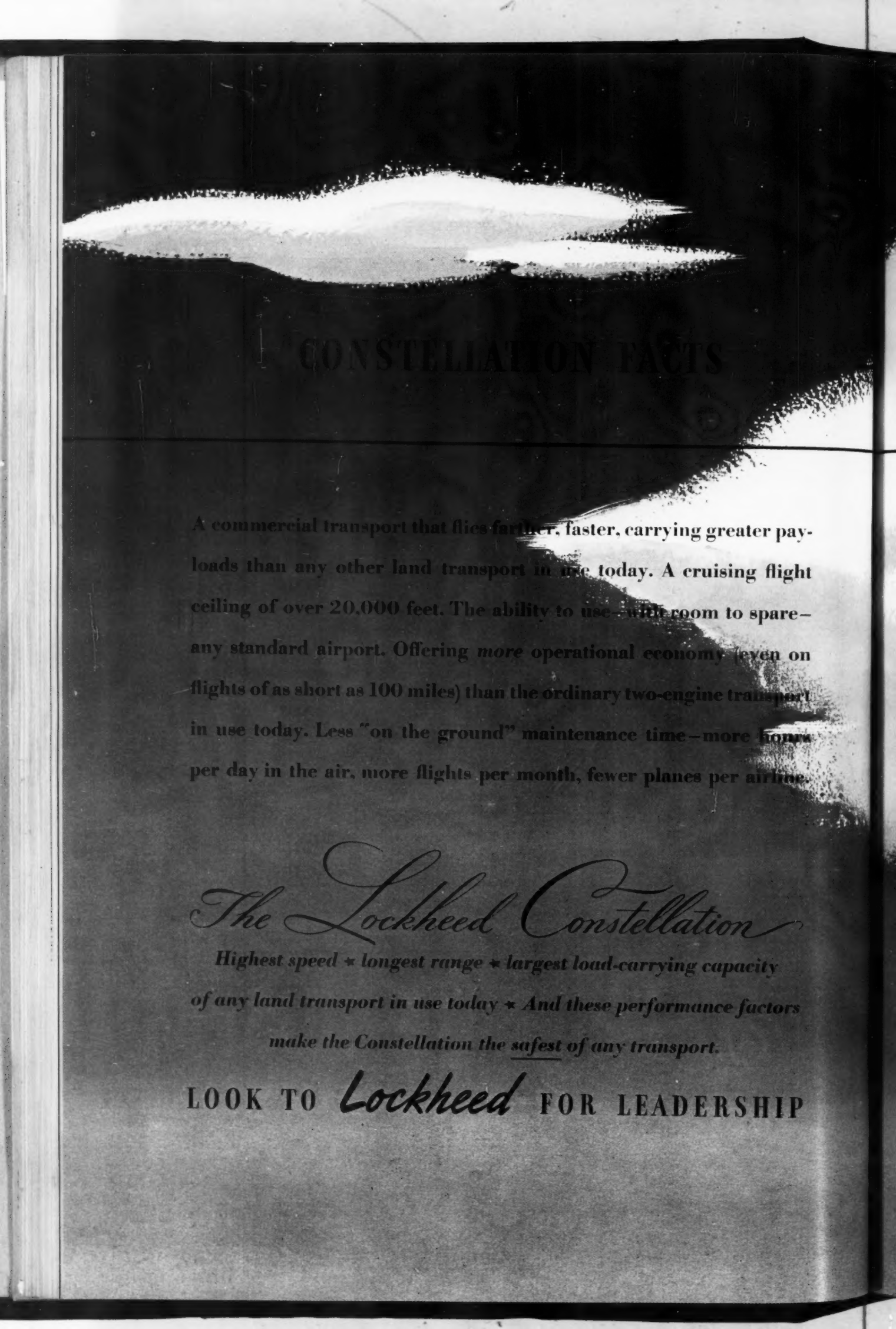
Rockets are made in the following calibers: 2.36 in.; 2.45 in.; a larger size for tanks and planes; and the 4.5 in., which is being abandoned and changed to 5.0 in. to match the Navy's of that size.

Since rockets propel themselves, instead of being driven by percussion in a gun, they are launched from very lightweight tubes. For example,

LEADERSHIP LIKE LIBERTY ISN'T INHERITED

Industry leadership is the product of vision and courage and skill; of seeing the future from afar, of fighting toward an ideal, of directing men and machines to the fulfillment of a onetime dream. This is the formula. And because leadership, like liberty, can't be inherited, the formula must be applied unceasingly—year after year—to keep such leadership in force. Thus—in their years—have evolved proud Lockheed names: Sirius, Orion, Electra, Vega, Lodestar, Hudson, Lightning P-38. Thus today the Lockheed Constellation, flying for the Army Air Forces, admirably maintains this tradition and is itself a vivid forecast of greater Lockheed planes to come.

The Lockheed Constellation


CONSTELLATION FACTS
A commercial transport that flies farther, faster, carrying greater payloads than any other land transport in use today. A cruising flight ceiling of over 20,000 feet. The ability to use—with room to spare—any standard airport. Offering *more* operational economy (even on flights of as short as 100 miles) than the ordinary two-engine transport in use today. Less "on the ground" maintenance time—more hours per day in the air, more flights per month, fewer planes per airline.
The Lockheed Constellation
Highest speed ★ longest range ★ largest load-carrying capacity of any land transport in use today ★ And these performance factors make the Constellation the safest of any transport.
LOOK TO Lockheed FOR LEADERSHIP

QUESTIONS

Q. I never see Lockheed's Constellation at our airport. Why?
– James S., Bangor, Me.

A. *All of the Constellations completed so far have been turned over to the U. S. Army Air Forces and are being used for long-distance and overseas transport.*

Q. What are the speed and rate of climb of the Constellation?
– Theodore Zielinski Jr., Milwaukee

A. *The Constellation cruises at more than 300 m. p. h. Fully loaded it climbs 1/3 mile per minute.*

Q. Pilots of the Constellation must be supermen! How can they handle a plane with such big control surfaces?
– Ernest S., Tampa, Fla.

A. *As a matter of fact, piloting the Constellation is not tiresome at all. Power boosters actually do the work of moving the rudders, elevators, ailerons and flaps at the pilot's bidding. However, the plane can be flown easily by manual control.*

Q. Is the Constellation as big as our biggest bombers?
– Sgt. Jack K., Ft. Benning

A. *Constellation is approximately same size as our largest bombers.*

Send in your questions...Address: Lockheed Aircraft Corporation, Department 69-55, Burbank, California

LOCKHEED

FOR NEW WORLD STANDARDS IN AIR TRANSPORTATION
LOOK TO *Lockheed* FOR LEADERSHIP

the 4.5 rocket has the fire power of a 105-mm. gun, yet while the launcher costs only $104, the 105 gun costs $8,406. The accuracy of rocket fire, from ground and plane, is being consistently improved, according to reports.

"Keep On With Engineering and Research"—Echols

Maj. Gen. Oliver P. Echols, assistant Chief of Air Staff, advocating replacement of one-fourth of the AAF's equipment each year for five years after the war, recommended recently to the Woodrum Postwar Military Policy Committee that aircraft manufacturers maintain large and competent engineering staffs on the development of military aircraft design in peace time. He says that all equipment will be obsolete within two or three years after the war.

Gen. Echols favors the proposal of Undersecretary of War Patterson for having a Research Board for National Security (which, he states, should have AAF representation) in the main body of the board and in all subcommittees which are concerned with aviation.

The Secretaries of War and Navy have already set up a Committee on Postwar Research, headed by Charles W. Wilson, which has recommended that the Board be composed of 20 civilians and 10 officers each from the Army and the Navy.

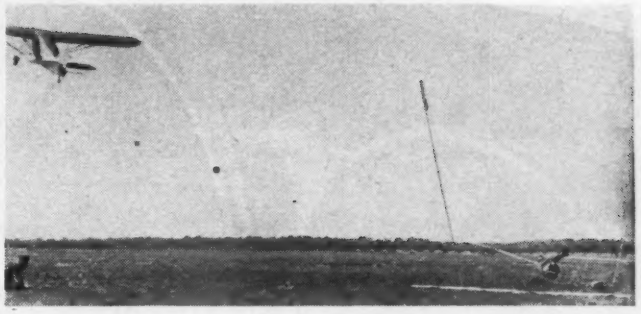
There is a question whether such Board should be under the National Academy of Sciences, or be established as an independent agency. The War Department does not want the agency to go directly to Congress when it is in need of funds.

Tax Law Change Sought To Aid Cut-Back Firms

Amendment of the federal tax laws to aid companies whose war production has substantially ceased and who anticipate drastic reductions in earnings has been recommended to the Republican Postwar Tax Study Committee by the Aeronautical Chamber of Commerce.

The recommendation was made in a letter from Eugene Wilson, Chairman of the Board of Governors of ACCA, to Rep. Daniel A. Reed, chairman of the committee.

Mr. Wilson asked that such companies be given the right ultimately to offset against accrued taxes the benefits to which they are entitled under the carry-back and postwar credit provisions. The amount of taxes ultimately to be paid would not be altered; only the time of payment would be affected.



WHISK-UP AND HAUL-UP

At Wright Field, men instead of mere containers are being picked up (see above) by specially fitted Noorduyn UC-64 in tests by ATSC. Wearing hook-up harness, skygoer sits on pad facing oncoming plane, then when gear connects he's on his way, legs high. There is said to be little shock since high acceleration is only momentary. After his takeoff, man is pulled up into plane. Photos below show how Coast Guard Sikorsky R-4 helicopters, employing U-type harness, make similar personnel pickups from sea—but without that initial "snap". (Press Association and International News photos.)

★ KNOW-HOWS ★

Stall-warning electrical system developed by United Air Lines uses instrument board lights to indicate continuously flow of air over wings, thereby warning pilot of dangerous conditions.

Compar seals, and similar parts, have been developed to outlast rubber 5 to 250 times besides being oil-resistant, states Resistoflex Corp., Belleville, N. J.

By making lenses for landing lights and airfield illuminators from new HM-122 Lucite, a tougher and clearer product has been achieved, reports DuPont.

High tensile electrode for welding aircraft steel, giving properties similar to parent metal, has been tested by General Electric Co.'s welding division, which states it gives satisfaction over a wide voltage range even in vertical welds.

Lightweight aluminum gasoline drum has been developed by Alcoa for the ATC and having brought weight saving of 31 lb. per drum, its use enables thousands more gallons of fuel and oil to be flown over the "Hump" than formerly, without increasing total tonnage.

Thirty sets of wings constructed entirely of magnesium have been in test service on Navy SNJ-2 advanced trainers since early '43. Satisfactory results with them are reported by Dow Chemical Co., which has been working with Bureau of Aeronautics on project. Wings are stated to be 14 percent lighter than those of standard aluminum.

Reversible pitch propellers for "air braking," developed by the ATSC and Curtiss-Wright, have enabled stopping of a heavy plane in 900 ft. after landing, instead of 1,500 ft. as when wheel brakes and flaps are used.

Magnetic coupled torquemeter for aircraft engines has been devised by Westinghouse to assist pilot in saving fuel through closer adjustments. Estimated additional range is 10 percent.

★ ASSEMBLY LINES ★

Fairchild's last UC-61K Forwarder has been delivered to AAF. Model has been in production since Sept. 1941. Facilities will now be concentrated on twin-engine C-82 "Flying Boxcars".

U. S. Rubber Co.'s Passaic plant has been awarded AAF Quality Control Rating, highest production award. Plant makes bullet-sealing hosing, anti-vibration mounts, air ducts, machine-gun chutes and propeller anti-icers.

Convair aircraft production now totals over 25,000 planes. Total weight of airframes and spares has passed 300,000,000-lb. mark.

North American Aviation is now building Mustangs for Chinese Air Force besides AT-6 Texans. Brazil, Canada, and Australia are now assembling or building AT-6's under license. This craft is being used by 28 different nations, company states.

Republic's Evansville, Indiana, plant, besides producing P-47's has now undertaken job of turning out B-29 engine cowlings.

P & W upped Kansas City engine output in Nov. from 1,000,000 hp. to 1,250,000 hp. and is prepared to keep up this pace until Japan surrenders. Increased production calls for additional 4,000 workers.

Buick Div. of GMC has now completed 60,000 P & W Twin-Wasps for Liberators. Total of 72,000,000 hp., entailing 3,300 engines per month, was reached in 32 months.

Minneapolis-Honeywell has announced completion of 30,000th electronic automatic pilot.

Wing stress instruction is provided in new film, "Wing Destruction Test", produced by Glenn L. Martin Co. to show methods of making checks on completed wing of PBM-3 flying boat.

Westinghouse Mansfield plant now makes engine mounts for Douglas A-26 Invaders.

Bendix Aviation Corp. announces that Eclipse-Pioneer Div. has produced nearly 12,000,000 aviation electrical equipment units in past 3 yr., products being motors, generators, and aviation instruments. Philadelphia Div. has totalled over $8,500,000 in precision devices and Fluxgate compasses. Zenith Div. has to its credit 2,800,000 carburetors for aircraft and wheeled equipment, while Wayne plant made 150,000 aircraft carburetors and 78,000 landing gear shock struts. Owosso Div. has produced 150,000 injection carburetors since June, 1942.

★ FOR THE RECORD ★

Anti-Friction Bearing Manufacturers Assn. has opened Ball & Roller Bearing Information Center at 16 E. 48th St., New York City 17.

Laister-Kauffmann Aircraft Corp., St. Louis, reports it has acquired assets and design rights of Bowlus Sailplane Co., Los Angeles.

Dynamic Air Engineering, Inc., builder of high-pressure axial-flow fans and fractional hp. motors, states it has taken over business and operation of Steel Forming Corp., Los Angeles.

American President Lines, has retained McCann-Erickson as advertising counsel "in connection with extensive plans for postwar steamship and airplane services to the Orient."

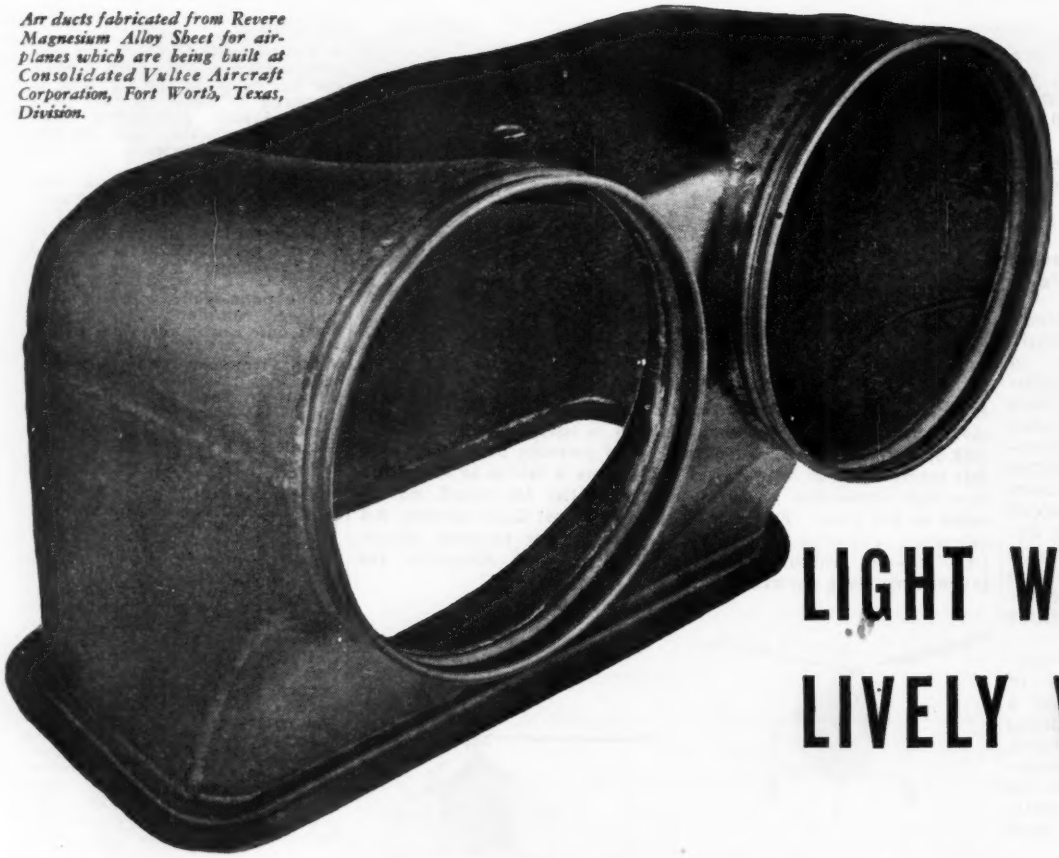
Surface Combustion, Toledo, announces purchase of additional factory space for increased production of Janitrol aircraft heater equipment.

Northwest Airlines states that Newell-Emmett Co. of N.Y.C. will handle its advertising account.

Western Gear Works, maker of airplane gears and actuating units, is now represented in the East by an office in New York City's Chanin Bldg., 42nd St. and Lexington Ave., N.Y.C. 17. Representative is Dean Swift.

Engineering Research Corp., Riverdale, Md., has appointed Pettingell & Fenton as advertising counsellors. Company produces Ercoupe plane and machine tools for aircraft builders.

Aero Insurance Underwriters states that Northeast Iowa territory, previously under its Chicago office, will now be handled by Kansas City branch. Also Eastern Ohio will now be under Chicago, rather than New York City, as formerly.



Air ducts fabricated from Revere Magnesium Alloy Sheet for airplanes which are being built at Consolidated Vultee Aircraft Corporation, Fort Worth, Texas, Division.

LIGHT WEIGHT IS LIVELY WEIGHT!

REVERE Magnesium Alloys

DON'T be misled by the inevitable fact that thus far the use of magnesium for structural purposes has been largely confined to the airplane. As more and more of this remarkable light metal becomes available (and more is being released every day) you will find magnesium creating the new light metal age, in which a great many things that move will do so more quickly and economically and easily because magnesium is used in them.

Remember that it costs money to move anything—trucks, trailers, elevator cages, railroad cars, buses, *anything.* And it costs money to ship to, and move around a plant, the materials of which they are made. It takes effort to move such common articles as vacuum cleaners, hand tools, portable typewriters, chairs. Weight reduction will be *so* important after the war!

Revere Magnesium Alloys are available now in the form of sheet and plate, rod and bar, tubes and shapes, forgings and forging stock. The Revere Technical Advisory Service will gladly assist you in obtaining magnesium's maximum advantages... Write for your complimentary copy of the new 32-page booklet, "Revere Magnesium Alloys and the Light Metals Era."

THE FOUR REVERE MAGNESIUM ALLOYS

Working Characteristics	"M"	"FS-1"	"J-1"	"O-1"
FORMABILITY	Good	Excellent	Fair	*
STRENGTH	Good	Good	Excellent	Excellent
WELDABILITY	Excellent	Good	Excellent	Excellent
DEEP DRAW	Excellent	Good	Fair	*
FORGEABILITY	Excellent	Excellent	Excellent	Excellent
MACHINABILITY	Excellent	Excellent	Excellent	Excellent

*Heat-treatable extrusion or forging alloy

REVERE

COPPER AND BRASS INCORPORATED

MAGNESIUM—ALUMINUM DIVISION

Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue, New York 17, N.Y.

CAB Opposition to Shipping-Company Airlines Attacked by House Merchant Marine Committee

. . . ATA against Act changes favoring the surface carriers . . . Air traffic highs in '44 gaged by Gorrell . . . State airline-tax tangle studied by CAB . . . Stiff "ground" competition seen for short-haulers.

The House Merchant Marine Committee, which has jurisdiction over the Maritime Commission and American merchant marine, has issued a report which uses strong language against the CAB for its stand against air operations by shipping companies.

This criticism is followed by approval of a bill which would authorize the commission to make conclusive findings, regardless of the Aeronautics Act or the board, as to the right of steamship operators to employ airplanes as auxiliaries to, or in lieu of, surface vessels.

If the commission finds that it has a right to authorize airplane operation by ship lines, and unless the board relaxes its position, then by process of law the high court will have to resolve the conflict.

Many opine that airlines don't have exclusive rights to airplanes in public service. Other critics say that if jurisdiction over air transport is divided between the board and the Maritime Commission, it can also be divided with other agencies, and there will be no air transport control as such.

ATA Against Act Changes Favoring Surface Lines

In its ninth annual meeting at Washington, the Air Transport Associatoin pledged support to the "30-yr. transportation policy of our National Legislature" and took a resolution opposing any change in the provisions of the Civil Aeronautics Act of 1938 regarding the control of an airline by surface carrier interests.

This action followed closely a report by the House Merchant Marine Committee advocating the use of auxiliary aircraft by shipping concerns, under authority which would be vested in the Maritime Commission by a pending bill.

Demand by railroads and bus lines for permission to operate or control airlines will be the major issue in further attempts by the new Congress to pass the Lea bill or similar legislation.

State Airline-Tax Tangle Studied by CAB

What to do about taxing airlines was discussed again recently by the Civil Aeronautics Board's committee on multiple taxation. The committee, which met in Washington under the chairmanship of Oswald Ryan, Board member, reached no final conclusions.

The study grew out of a decision by the Supreme Court denying the appeal by Northwest Airlines from a Minnesota court ruling that all that company's equipment passing through Minnesota is subject to the state's property tax. The high court ruling would permit each state served by an airline to tax all of the lines' airplanes.

Some members of the tax committee recommended a law authorizing the federal government to supervise allocation of airline tax privileges among the states. A special bureau to do this job was favored by some, while others would have it done by an existing agency. The present system of taxing aviation fuel by the states was brought into question, and some members advocated transfer of such taxation to the federal government.

The problem of international airline taxation was foreseen. It was suggested that all countries served by foreign airlines exempt them from taxation, and that each international airline be taxed only by the country of origin.

Stiff "Ground" Competition Seen for Short Haulers

"For some years, at least, I simply do not believe that a scheduled air route stopping at small cities every few miles is going to offer very effective competition to the short-haul advantages of railroads, buses, and private automobiles," said Chairman L. Welch Pogue of the Civil Aeronautics Board, speaking before the National Aviation Trades Association, at St. Louis.

Mr. Pogue added, "I do have the conviction, however, that there will be frequent but irregular demands for air service to and from small cities which in any particular region and in the aggregate will be sizable."

He went on to suggest that air taxi services be established between points not having scheduled lines. Then if the traffic becomes sizable and regular, application can be made with the Board for a route certificate.

Air Traffic Highs in '44 Gaged by Gorrell

Traffic estimates for the year 1944 indicate new records by domestic air carriers in all branches of service, according to Col. Edgar S. Gorrell, president of ATA.

The return of additional planes to the airlines together ment and high load factors lead to calculation that the domestic lines will show gains of 22.5 percent in revenue passenger-miles, 24.7 percent in mail pound-miles, and 7.2 percent in express pound-miles flown during the year as compared with 1943.

Estimates for the 1944 calendar year indicate that the domestic carriers will report revenue passenger-miles in excess of 2,000,000,000, as compared with 1,632,452,433 in 1943, 1,417,525,877 in 1942, and 1,384,733,251 in 1941.

Mail pound-miles flown during the year are gaged to exceed 90,000,000,000, as against 72,133,899,534 last year, and 42,332,048,722 and 26,236,027,723 pound-miles in the years 1942 and 1941, respectively.

Express pound-miles are estimated at 33,500,000,000. This would compare with 31,257,460,811 pound-miles in 1943, 23,803,586,614 pound-miles in 1942, and 10,517,102,345 in '41.

Gross revenues for 1944 should exceed $150,000,000, consisting of approximately $108,000,000 passenger revenue, $30,000,000 mail revenue, $9,000,000 express revenue, and $3,000,000 from miscellaneous sources. In 1943, total gross revenue was $123,368,870, as compared with $108,147,909 in 1942, and $97,311,133 in 1941.

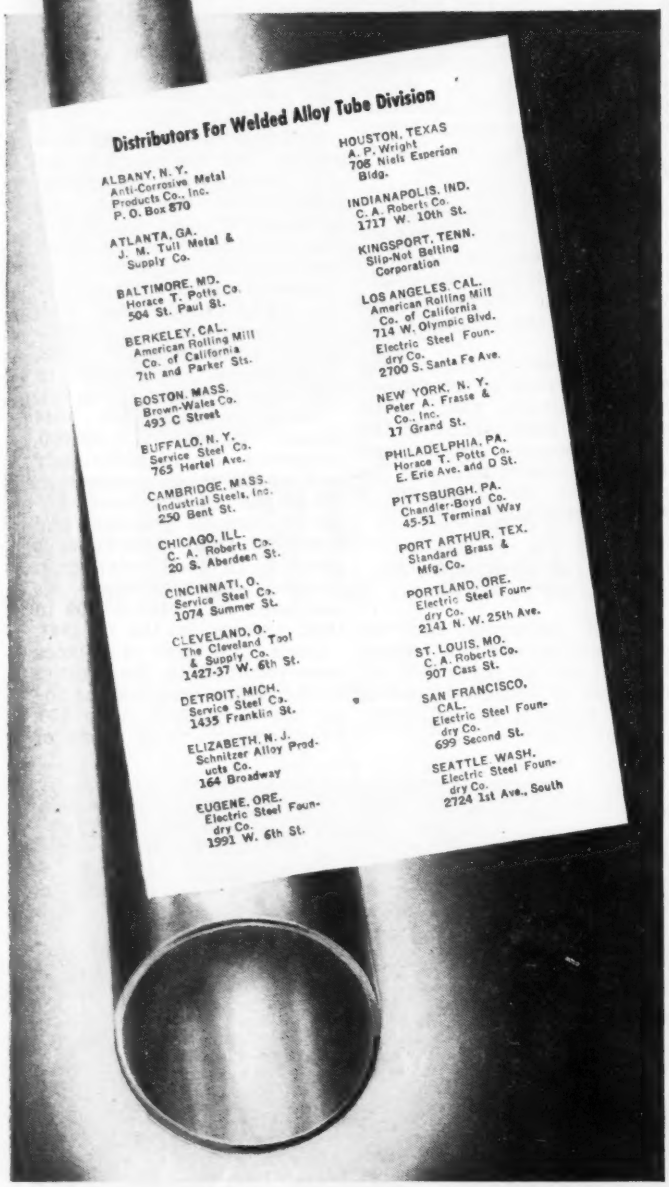
During the year 112 planes were returned to the airlines by the Army, bringing the total planes at Nov. 1 to 300. This compares with a low of

CAA MANAGERS PLAN FOR PEACE

In first full-roster gathering of CAA regional managers, topic tackled was coordination of postwar operations. CAA Administrator T. P. Wright is seen seated at right. Standing, left to right, are: H. A. Hook, Sixth Region; J. E. Sommers, Asst. Administrator; M. C. Hoppin, Eighth Region; W. E. Kline, Fifth; J. E. Beardslee, Ninth; W. M. Robertson, Second; and C. I. Stanton, Deputy Administrator in charge regional offices. Seated: O. D. Harwood, First; A. S. Koch, Asst. Administrator for Foreign Operations; H. R. Neely, Third; L. C. Elliott, Fourth, P. R. Morris, Seventh; and W. A. M. Burden, Asst. Sec. of Commerce.

Stainless Tubing Available from These Distributors

Whether it is a production emergency or a routine matter of getting the required analysis, size or gauge — get in touch with your nearest Carpenter Welded Stainless Tubing Distributor—listed below. Ample stocks are carried by all distributors backed by mill stocks to give you the fastest possible service. Call on your Carpenter Distributor also for help in the selection, application or fabrication of Welded Stainless Tubing.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ATLANTA, GA. J. M. Tull Metal & Supply Co.
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ELIZABETH, N. J. Schnitzer Alloy Products Co. 164 Broadway
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THE CARPENTER STEEL COMPANY

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WELDED

STAINLESS TUBING

164 airplanes on Dec. 31, '42.

Despite the increase in seats available, priority travel continues heavy, especially on the transcontinental routes and around industrial centers. On the transcontinental flights priorities are running in excess of 70 percent, while in the heavy industrial areas priorities range from 50 percent to 59 percent.

Passenger load factor this year is running well over 90 percent, as compared with 88.01 percent in 1943, 72.21 percent in 1942, and 59.13 percent in 1941.

Before the war a daily employment of planes that averaged 6 to 7 hr. of actual flight was regarded as good performance. The daily scheduled flights this year represented a national average of about 1,825 mi. per plane per day, and approximately 11 hr. of flying hours per plane in every 24 hr.

★ CROSS COUNTRY ★

Continental Air Lines' Pres. Robert F. Six announces company will give the returning employee-veteran job preference, including wage raises since he joined Armed Forces if he formerly held automatic-pay-increase job.

Railway Express Agency reports first nine months of '44 saw 327,013 air-rail shipments with revenue well over $3,000,000 as against 292,803 units previous year.

Northeast Airlines proposes nine new routes in New England areas. Possibility of later use of helicopters is mentioned.

Norseman Air Transport, organized and to be operated by AAF veterans, plans wide routes from Hartford, Conn., headquarters to serve New England and to connect with N. Y. C.

Twenty more transports (Douglas DC-3 types) have been allocated to airlines. To American Airlines, 5; UAL, 3; PAA, EAL, NWA, and TWA, 2 each; and one each to Panagra, PCA, Braniff, and Western. Part of next group will be Lockheed Lodestars.

TWA is advertising scheduled flights to Calcutta and Cairo—to be made when authorized.

Northeast Airlines announces signing of contract for three 60-passenger Douglas DC-4's.

CAB reports total airline net revenues dropped nearly $500,000 for year ending Aug. 31, 1944 in spite of gross rise from $116,000,000 in 1943 to $141,000,000 in 1944. Except in freight and express departments, all operating expenses increased.

Trans-Canada Air Lines claims new trans-Atlantic England-Montreal westbound record of 11 hr. 26 min.

American Export Airlines has taken delivery of first of two Douglas C-54's to be used in New York-to-Foynes passenger route after Jan. 1.

ATA Meteorological Committee announces publication of "Journal of Aeronautical Meteorology," a quarterly edited by E. J. Minser, the Association's chief meteorologist.

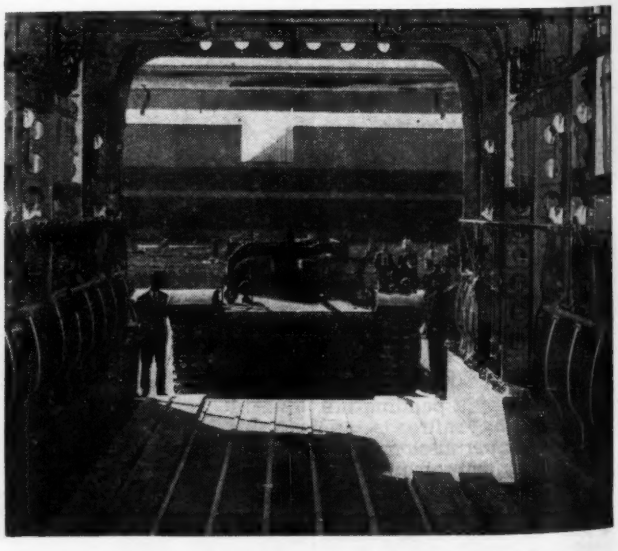
Northwest Airlines is reported to have been invited by Washington State to move to Seattle—to "get out from under" those Minnesota taxes.

Department of Commerce figures that air freight program linking U. S. and Paraguay would give airlines 8.1 percent of $2,380,000 annual trade.

TWA has opened new service to Topeka, Kan., seventh state capital on routes operated by company.

UAL's fourth cross-country air-cargo route—San Francisco-Chicago—brings daily schedules up to 18,458 freight-miles.

All American Aviation has filed plans with CAB for eight air pick-up routes in New England, connecting with N.Y.C. as southern terminal.



PACKET'S "INNARDS"

Cargo-stowing conveniences of Fairchild C-82 Packet's squarish fuselage have especially drawn attention of those who-plan peacetime air freight and express operations. This from-inside-out view reveals cargo-compartment appurtenances, also shows that tail doors swing fully clear. Bottom of fuselage is height of standard truck from ground. (Also see photo, page 227 Dec. AVIATION.)

Nazis Hurl New V-2; "Plan" V-3 Against U. S.

. . . Australia and New Zealand creating air monopolies . . . Brazil turns down TACA.

The month saw England, as well as Allied positions on the Continent, hit by a newer German revenge weapon, this time the V-2 14-ton true rocket calculated to travel at supersonic speeds, making its approach inaudible. Estimates put the velocity of this projectile at 1,200 mph. in a fall from a peak altitude of some 50 mi.

Reports at this writing indicate V-2 is probably 22 feet long and several feet in max. dia., carrying about 1 ton of explosive at maximum range, and is radio controlled for some time after launching. Eyewitness reports of actual firing tell of many bad starts and control difficulties, a habit in which V-2 bears similarity to V-1. V-2's high speed is stated to result in deeper craters and accordingly less ground range of explosive damage than V-1.

While exulting over V-2, the Germans also announced that America's East Coast would soon be the target for a still-newer V-3 rocket weapon. But rocket experts in this country have estimated that such a projectile would have to weigh some 2,500 tons to carry 1 ton of explosive for the 3,000 mi., and further that it would cost an exorbitant price gaged in millions of dollars.

However, Germany might hit this country with some V-type weapon, using submarines as launching platforms, or such surface vessels as the "Westfalen" catapult ship, which incidentally was recently sunk by the British.

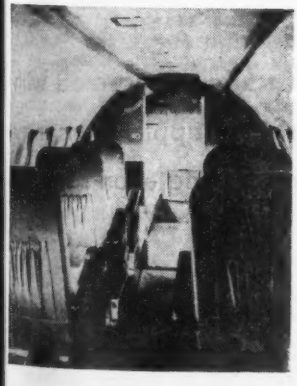
Australia and New Zealand Creating Air Monopolies

Both the Australian and New Zealand governments have taken steps to set up state-owned monopolies for their internal and external air services, similar to the plans already adopted by Canada and South Africa.

Australia's Acting Prime Minister Forde announced that the Australian Government will acquire all privately owned airlines in Australia, of which there are quite a few, and hand over all operations to Qantas Empire Airways, which has both internal and international franchises.

New Zealand has arranged to release military pilots and other personnel to Tasman Airways, which for some time has been maintaining a service to Australia, and other government steps are contemplated to improve the organization.

These steps are generally considered to be the result of the recent Empire Air Conference, and similar actions are expected to take place in England.



"FORTRESSLINER"

New long nose (photo above) is a distinguishing feature of converted Boeing B-17's recently put in service on Swedish airlines. Transformed ship carries 14 passengers in revamped interior (top photo) while 3 tons of cargo can be stowed in reconstructed bomb bays. Plane seen here flies Sweden-Scotland run. Three of five forced-down Fortresses have been made into such transports following their "loan" by U. S. government. (Acme photos)

WORLDATA . . . . . By "VISTA"

That reciprocal U. S.-Spain civil aviation pact calls for three routes bringing connections with Madrid, and now ATC is preparing to begin the operations over them. Incidentally, British announcement of the start of a daily London-Madrid service, based on an arrangement made in '40, may be taken to imply that England is also putting some accent on this business of bilateral agreement.

Our new American routes to Spain fit in with the world air service pattern advised earlier by CAB. The runs from the U. S. are (1) by way of South America and West Africa to Seville, Madrid, and Barcelona, then to Paris and beyond; (2) by way of Lisbon to Madrid and Barcelona, then to Marseilles and beyond; and (3) by way of Lisbon to Madrid, then to Algiers and beyond.

While Spain is thus authorized to start air services to the U. S., it is not yet prepared to do so. In any event, ports of American entry are to be determined by future negotiations. As for the operator of such services, Spain's Iberia organizatoin would get the nod, since it has received a government monopoly for air services.

A plan for those British Commonwealth airlines which are contemplating intercontinental services is proposed by the British magazine *Aeroplane*, and while some of the routes are familiar, others give a clear indication on Britain's new line of thinking. The Canadian service would connect China, Japan, Siberia, Alaska, Canada, England, and Moscow. Then an Australian service would extend east from London and terminate at Vancouver, B. C., intermediate points being Egypt, India, Australia, New Zealand, Samoa, Hawaii, and San Francisco. And a South African service would link Capetown with London, Miami, and India via separate routes.

Other special proposals are a route from London to Chili, via Dakar and Brazil, also an India-Tokyo extension for the Far East service. Incidentally, worth mentioning that some surveying has already been done through RAF Air Transport Command planes which now fly between London and Sydney via Montreal, San Francisco, Honolulu, the Fijis, and New Zealand.

Brazil Turns Down TACA

TACA, which for years has been competing against Pan American, suffered a setback in its expansion plans when high Brazilian officials reversed their decision to grant Aerovias Brazil, TACA subsidiary, a specified route inside Brazil.

The route, extending from Rio de Janeiro to Manaos on the upper reaches of the Amazon, went to Panair do Brasil, PAA subsidiary, despite TACA's reportedly lower mail-contract bid.

Having recently obtained American financing, TACA has nevertheless branched out with subsidiary lines in several Central and South American countries.

★INTERNATIONAL BRIEFS★

KLM has resumed daylight flights between the British Isles and Lisbon, after having flown the route at night since June 1943, when the DC-3 airliner carrying Leslie Howard was shot down by the Germans.

Nazis have equipped their FW-190's with a device to eject the pilot from his cockpit in emergencies or after ramming an Allied craft, a stunt becoming a specialty with some squadrons.

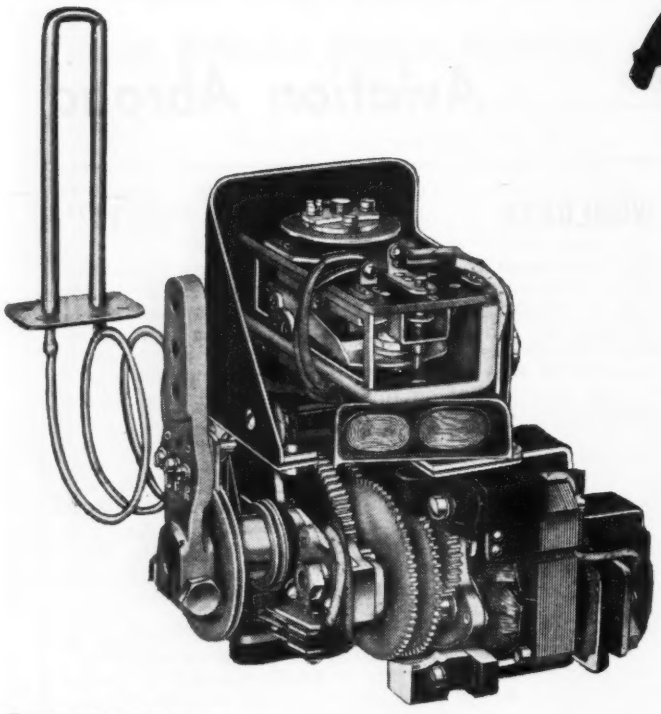
Railway Air Services has started England's first civilian internal air service since 1939. Its run connects London with Liverpool and Belfast.

Germany's twin-jet Me-262 is very similar in appearance to Bell's P-59 Aircomet, except that the Me-262's jet-units are set farther out on the center-section. Armament on the Nazi craft comprises four 30-mm. cannon of a new type.

Japan has several new aircraft —the Ginga, which Nippon contends is a match for the Hellcat; the Susei, supposedly more formidable than the Helldiver; and a twin-engined fighter resembling the P-38, which American forces have dubbed the "Irving".

The Swedes now operate to Lisbon via London, having dropped Berlin from the route.

AUTOMATIC CONTROLS *for* AIRCRAFT FLIGHT OPERATIONS



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White-Rodgers modulating temperature controls and Servo Actuators provide the safety of automatic local or remote control and assure greater freedom for the pilot in applications involving the control of:

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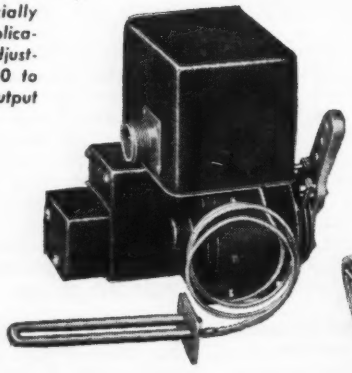
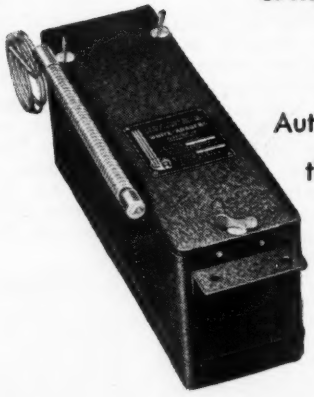
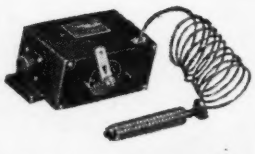
CARBURETOR THROTTLE





Authorized manufacturers concerned with the above or similar applications may secure engineering data on request.

Sturdy and compact, this modulating control weighs but 4.35 pounds, is dust-proof and moisture resisting. Dimensions less than 10" x 3" x 5".



Modulating temperature control used for regulating carburetor air temperature.

POST-WAR PRODUCTS NEED CONTROLS, TOO

Whatever is on your drawing boards for post-war, it's two to one it will have automatic features. If these features involve control by temperature or pressure, investigate controls made by White-Rodgers. Write today for catalog and engineering data.

LET'S GO! U.S.A. · KEEP 'EM FLYING!

WHITE-RODGERS ELECTRIC CO.

SAINT LOUIS

Controls for Heating · Refrigeration and Air-Conditioning

Fairchild Camera & Instrument Corp. reports net profits of $977,429 for the nine months ended last Sept. 30. An addition of $100,000 was made to reserves for reconversion, against $200,000 for this purpose the previous year.

Pan American Airways Corp. will now ask stockholders' approval of a plan to split the common stock two-for-one and to offer rights to purchase additional stock. It is expected that $25,000,000 will be raised. Atlas Corp. will underwrite the new offering to that amount. Shareholders will have the right, after the split-up, to purchase one additional share for each two held, together with an option warrant good for 2½ yrs. to purchase another share. Result eventually will be to increase the outstanding stock from 1,993,261 shares to 7,973,044 shares. This is the first step in providing financing for PAA's postwar equipment program, which may exceed $100,000,000. Additional funds may be secured later through preferred stock or equipment trusts.

Fairchild Engine & Airplane Corp. has arranged with four New York banks for a $25,000,000 revolving credit to meet current and termination needs. Pres. J. Carlton Ward, Jr., recently stated that contract cancellations on trainers and engines have prevented expansion of 1944 sales, which are not expected to equal those of 1943. The company's large proportion of cost-plus fixed-fee contracts last year adversely affected profit margins and it is hoped to convert these contracts to a fixed price basis as soon as possible.

National Airlines may be the next company to have aviation stock listed on the New York Stock Exchange, for it is understood that this fast-growing line has such an application "in the works".

Lockheed Aircraft Corp. reports net profits of $2,751,562 or $2.56 a share for the six months ended June 30, 1944. (For the year ended Dec. 31, 1943, net profits of $7,988,420 or $7.42 a share were reported by this company.) Sales for the six months were $329,483,376. With 91 percent of Lockheed's backlog on a cost-plus-fixed-fee basis, Pres. Robert E. Gross does not expect profits for the last six months of '44 to be as large as in the first half. Mr. Gross warned stockholders that dividend payments may be interrupted to preserve resources against postwar readjustments. Payments totaled $1.50 a share in 1944.

Beech Aircraft stockholders will soon be asked to approve an increase in the authorized capital stock from 500,000 to 1,500,000 shares. The annual meeting, usually held Dec. 14, has been postponed until the annual report is ready for publication. Final renegotiation of 1943 earnings reduced net to $5.54 a share compared with $10.08 a share reported earlier. Total government refunds were $20,953,000 compared with a reserve of $14,242,950 set up by the company. Final net income was $2,216,597 instead of $4,035,965.

United Aircraft Corp. reports profits of $12,573,763 or $1.44 a common share for the nine months ended Sept. 30, 1944, against $11,982,323 in the like '43 period. Shipments were $582,965,938 against $527,708,730 in the same '43 period.

Thompson Products plans to purchase the Thompson Aircraft Products plant in Cleveland owned by the Defense Plant Corp. if satisfactory terms can be arranged with the government.

Eastern Air Lines reports net profits of $721,684 or $1.22 a share for the nine months ended Sept. 30, 1944, against net profits of $758,461 or $1.20 a share in the like '43 period. Third quarter net was equal to 48c. a share against 21c. the previous year.

American Airlines stockholders have approved a two-for-one split of common stock and authorized 200,000 shares of new preferred. This represents a value between $60,000,000 and $70,000,000 (at present market prices) in possible additional capital funds available for future needs. In addition the company has about $10,000,000 in cash on hand for capital purposes.

Dividends: Curtiss-Wright Corp. declared a 75c. dividend on common stock payable Dec. 27. A similar amount was paid in 1943. . . . Wright Aeronautical paid an $8 dividend last year against $7 in 1943. . . . Aviation Corp. paid a 10c. dividend on Dec. 26, making 20c. for the year. . . . Fairchild Engine & Airplane paid 20c. last month, same as in '43. . . . National Aviation disbursed 50c. in December, bringing the year's payments to 75c. same as in '43. . . . Air Assoociates paid 20c. a share on Dec. 8. . . . United Aircraft paid $1.50 on Dec. 15.

ADDING IT UP.....By RAY HOADLEY

Review and forecast. On the average, earnings of the aircraft industry in the just-closed year of 1944 probably were about on a par with those of the preceding year. The gains to be reported by some companies probably will be offset by declines which, we've heard, other concerns anticipate. Actually, the management of most companies hesitate to make any estimates on their 1944 results—until they have finally decided on how much will be set aside in reserves, or until they clear the renegotiation hurdle that always confronts them every year-end.

Sticking Out Our Chin. However, it seems a fairly good guess that 1945 volume, and earnings too, will run quite sizably under last year's levels. Despite the recent German push, further cutbacks, appear inevitable this year. At the same time it appears likely that the present heavy tax burden will continue on until the Pacific war is over. And it's a safe bet that the aircraft industry will continue to show the smallest percentage of return on net sales of any of the major industries. The return was only 1.5 percent in 1943 against 2.1 percent in 1942.

Airlines' Outlook. Gross revenues of the airlines last year were in excess of $150,000,000 against $123,000,000 in 1943, and every sign points to new and substantial peak levels this year. Not only will the lines have more equipment available but there also will be a mounting demand for transport facilities to move war goods and personnel across the country en route to the Pacific fronts. Earnings, too, will be higher this year, although the gains may not fully reflect increased volume, since more companies are likely to hit the excess profits tax brackets.

Airline Financing. Three New York banks and an insurance company have worked out long-term airline financing plans that have attracted considerable interest in Wall Street and trade circles. It is a sort of "cradle to the grave" plan in that not only new transport equipment is involved but also airports, hangars, working capital, and development work. For planes, credit would be provided from the drawing board stage on through to the complete obsolescence of the craft.

A Three-Cornered-Plan. The insurance companies' part would be either to provide longer-term credits, such as mortgages on real estate, or to participate in the longer-term phases of financing the airplanes themselves. The commercial banks would handle short- and medium-term credits, and the regular investment banking channels would raise the necessary equity capital. Sponsors of the program feel that this is the only way to avoid piecemeal financing in a comparatively new industry.

Authors of the Plan. The Bankers Trust Co., Chase National Bank, New York Trust Co., and the Mutual Life Insurance Co. are the firms behind the plan. They intend to make it available for use by all banks and insurance concerns that are interested. According to the *Wall Street Journal*, about half of the airlines have been consulted on the program, but there have not as yet been any actual financing negotiations. Gordon D. Brown, on leave from Douglas Aircraft, has acted as an advisor in formulating the plan.

Looking Ahead. When an employee queried whether his job would end with the war, Beech Vice-President John Gaty wrote him that Beech expects to have a reasonable amount of capital accumulated plus a $50,000,000 loan that will also become available through the reconversion period, also that virtually all company facilities will be owned free and clear. In addition, he said, new designs are awaiting development and production when manpower is available and there is a backlog of orders on present models scheduled for postwar delivery.

ONLY THOSE THUNDERBOLTS

COULD HAVE SAVED OUR BACON THIS MORNING!

"You all know how bad A needs pictures for the b "blitz" they're planning. The C.O. told us to get' ...and he don't mean maybe... It was another job of sweating it out, and brothers did we sweat. the flak looked like a solid wall and about the time we managed to sneak through and get a coup of swell takes, things began to happen... A flock of those one-o-nines that Heinie's been saving, to us on as their personal meat... my port number two quit cold... starboard number one start smoking... our navigator copped a packet, the intercom went... then, just as I was begining to wo der what a shor'nuff pair o' wings would feel like, assorted hell broke out among Schickelgrube spiteful lads... One burst into flame off my port wing, a gent making a head-on run disintegrat ...and by the time I limped around and headed for home, two more Jerrys were spinning down a the rest of the visiting firemen hightailed away from there... Believe me, chums, I was betwee gulp and a prayer when two *P47's, who'd apparently been the total rescue squad, lined up ov our tail, proceeded to wet nurse us home, and, as though it were just another routine chore, flipped around and went calmly back to the wars."

***STATISTICS FROM ALL FIGHTING FRONTS DEMONSTRATE THE UNMATCHABLE PERFORMANCE OF THE "THUNDERBOLT"**

REPUBLIC AVIATION

CORPORATION

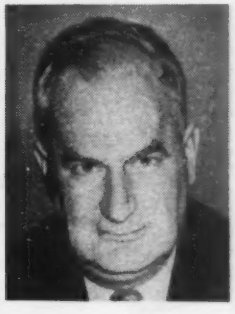
Specialists in High-speed, High-altitude Aircraft » *Farmingdale, Long Island, New York, and Evansville, Indi*

Aviation People

DR. ALBERT E. LOMBARD, JR. (left) has been named engineering consultant specializing in product development for Convair. He was formerly engaged as special ass't. to director of aircraft resources control office, also to director of ATSC, was executive ass't. with WPB, and was connected with WMC. **VIOLA FEATHERSTONE** (center) is new chief counselor at Convair's Miami Div. and will direct counselor service as divisional staff member. Former capacity was as sec. to treas. of div. **GEORGE C. FORD** (right) has been appointed works mgr. of company's Vultee Field Div. and will have direct responsibility for production of major assembly units for Convair's new B-32 Dominator, B-24 Liberator, PB4Y naval patrol bomber, and Lockheed P-38. Prior to present assignment, he had served as chief of industrial relations, and supervisor of education and training.

O. THEODORE LARSEN, v.-p. and gen. mgr. of Trans-Canada Air Lines, is scheduled to return to UAL as asst. to J. A. Herlihy, v.-p. of operations. He first joined UAL in 1929 as meteorologist at Omaha, and was supt. of dispatch when he left company in 1937 to go with TCA.

CAPT. LUIS DE FLOREZ, USNR, has been presented with Robert J. Collier Trophy for 1943 by NAA, for his contribution to safe and rapid training of combat pilots and crews through development of synthetic devices. He is a graduate of MIT and former consulting engineer.



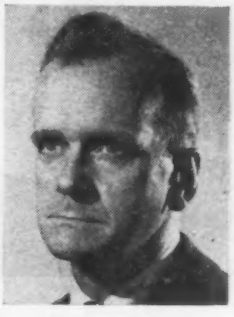
LEOPOLD H. P. KLOTZ has been elected pres. of Luscombe Airplane Corp., succeeding **A. C. Hastings, Jr.**, former Luscombe official, recently resigned. In his new position, Mr. Klotz will have the benefit of substantial company experience, having previously served as v.-p. and treas. (Bruno photo.)

PAUL W. PATE has recently been designated supt. of Delta Air Lines' new air cargo dept. He joined DAL's planning and research dept. after years of experience in motor freight, and served with Army Air Corps handling freight and troop movements at Maxwell Field and Courtland Air Base.

H. W. CROWTHER is now system supt. of maintenance for TWA, succeeding William Maxfield who resigned to go with Western Air Lines. Mr. Crowther had started with TWA in 1929 as mechanic and successively served as inspector, crew chief, maintenance foreman, supervisor, and ass't. maintenance supt.

HARMON A. HARRIS of Panagra's New York traffic dept. has been made public relations and advertising mgr. for South America, with hq. at Lima. He was previously associated with the publicity dept. of AA where he edited house organ, and was also affiliated with Raymond-Whitcomb.

ROY C. SYLVANDER has been appointed director of engineering of Bendix Aviation Corp.'s Eclipse-Pioneer Div., succeeding **W. A. Reichel**, recently resigned. For the past three years he has been chief engineer, concerned with development and production of company's flight, navigation, and engine instruments.



WILLIAM B. MOORE, operations mgr. for All American Aviation has been made v.-p. in charge of operations. He also previously served as operations mgr. of military cargo div. Prior to affiliation with All American, he was manager of State Airport located at Harrisburg, Pa.

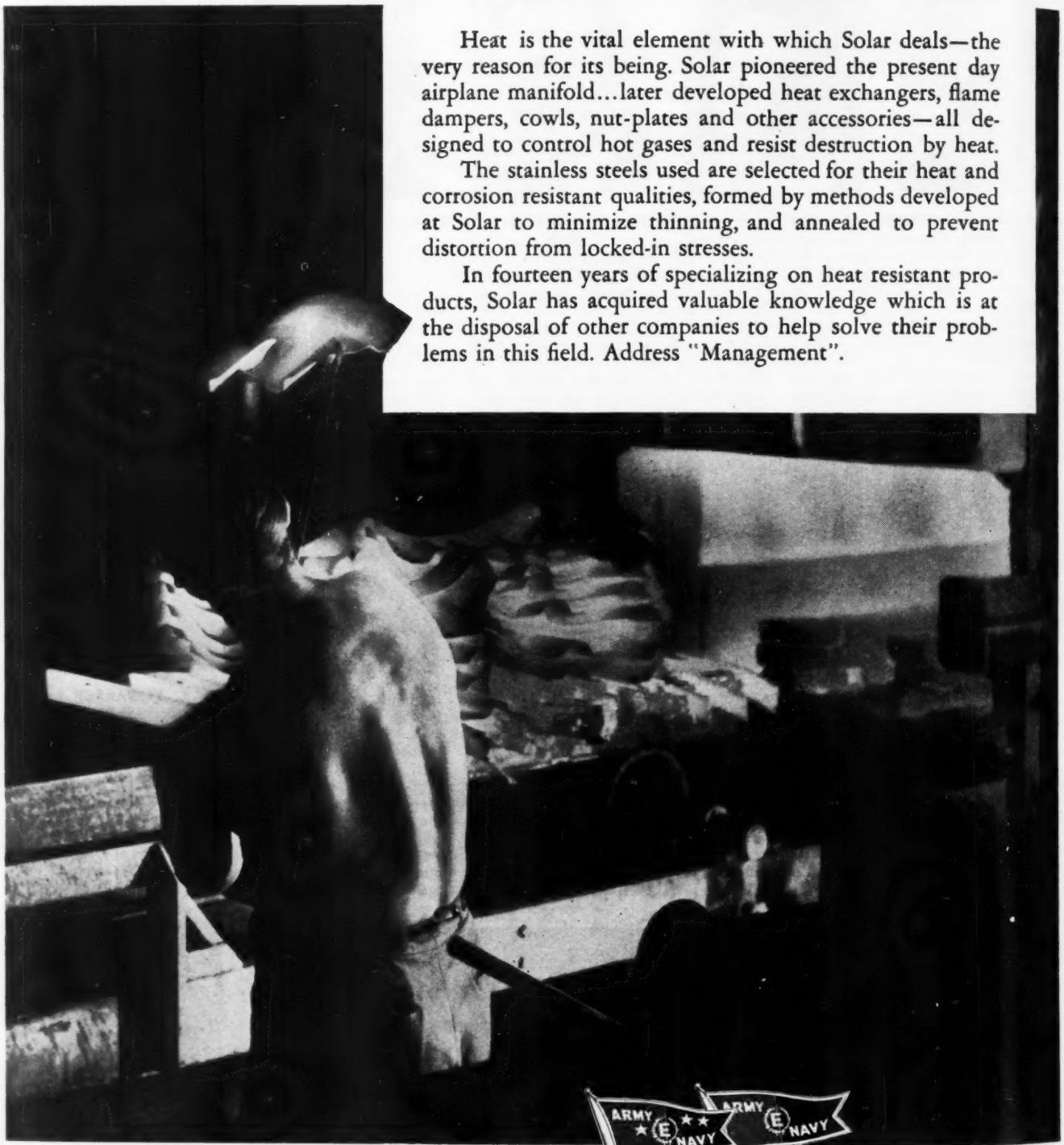
PAUL E. HOVGARD, director of flight test at C-W's Buffalo Airplane Div. has been made associate director of research laboratory. Previous affiliations were with Kellett and Pitcairn as chief engineer, Pennsylvania Aircraft, and as Martin chief research engineer and designer.

ARTHUR NUTT is new executive of Packard Motor Car Co., assuming duties of director of company's aircraft engineering div., bringing with him 25 yr. of broad experience in aircraft engine development. He was formerly associated with Wright Aeronautical Corp. as v.-p. of engineering.

GOULD B. MARTIN (left) has joined public relations staff of Fairchild Engine & Airplane Corp. as publicity mgr. after handling UAC's Hamilton Standard Div. publicity for two years. Previously, he had been in public relations and advertising activities in N. Y. C. **T. KELLY PIERCE** (right) has been named gen. mgr. of company's Duramold Div. which he joined in '43 after 19 years in the wood industry including capacities of gen. supt. with Hay & Co., and gen. mgr. of Dominion Plywoods, Ltd. In new position he will supervise production under new AAF contracts. (Tommy Weber photos.)

Turning on the Heat...

To Resist Heat Destruction!



Heat is the vital element with which Solar deals—the very reason for its being. Solar pioneered the present day airplane manifold...later developed heat exchangers, flame dampers, cowls, nut-plates and other accessories—all designed to control hot gases and resist destruction by heat.

The stainless steels used are selected for their heat and corrosion resistant qualities, formed by methods developed at Solar to minimize thinning, and annealed to prevent distortion from locked-in stresses.

In fourteen years of specializing on heat resistant products, Solar has acquired valuable knowledge which is at the disposal of other companies to help solve their problems in this field. Address "Management".

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ENGINEERING DATA

Research 1

Titled *Research In Action*, brochure from Battelle Memorial Institute, Columbus, Ohio, describes, in picture and text, equipment and methods employed in industrial research. A non-profit institution, activities range from development of new materials and improvements in old to evaluation of business ventures and marketing and production surveys.—AVIATION, Jan., '45.

Natural and Synthetic Rubber.....2

New Bulletin 8000 from B. F. Goodrich Co., Akron, Ohio, superseding one of same number dated Oct., 1942, lists properties of both natural and synthetic rubber and tabulates comparatively values possessed by each grade.—AVIATION, Jan., '45.

5-In. Slide Rule.....3

All-plastic 5-in. slide rule, stated to feature high accuracy, is topic of circular from Chas. Bruning Co., Chicago.—AVIATION, Jan., '45.

Detail-Engineers' Glass 4

Booklet from Engineers Specialties Div., Universal Engraving & Colorplate Co., Buffalo, describes two new types of engineers' glass, translucent, permanently ruled with detail lines, and with translucent vellum cemented onto glass directly over and in contact with lines.—AVIATION, Jan., '45.

PRODUCTION

Cutting Fluids 5

Containing data on steels, machinability, hardness, tools, speeds and feeds, and on selection and use of cutting and grinding fluids, booklet has been issued by D. A. Stuart Oil Co., Chicago, titled *Cutting Fluids for Better Machining.*—AVIATION, Jan., '45.

Vulcanized Fibre.....6

Booklet GF 3 from Continental Diamond Fibre Co., Newark, Del., lists properties and other information on vulcanized fiber, and on five other non-metallic basic materials.—AVIATION, Jan., '45.

Rivet Facts 7

Pheoll Mfg. Co., Chicago, offers illustrated manual on use of "Hi-Shear" rivets, detailing pertinent facts and advantages of gun and squeezer methods of installation, progressive forming, correct length, and simplicity of their removal.—AVIATION, Jan., '45.

Fasteners 8

Description, specifications, and applications of company's aircraft fasteners are contained in new booklet from Camloc Fastener Corp., New York City.—AVIATION, Jan., '45.

Clamps and Fittings.....9

Catalog P-1 from Punch-Lok Co., Chicago, contains technical data on, and description of, line of clamps and fittings for hose, pipe, and electrical use.—AVIATION, Jan., '45.

Better Bronze 10

Bulletins No. 120 and 121 from Tin Research Institute, Greenford, Middlesex, Eng., describe new processes by which bronze with increased strength and toughness can be made from common grades of tin and copper without special equipment.—AVIATION, Jan., '45.

Materials Handling System.....11

Booklet from Factory Service Co., Milwaukee, titled *The Turner System of Materials Handling*, describes system based upon vertical extension of the perfect square and indicates benefits of mobility, orderliness, and coordination in manufacture of parts or products.—AVIATION, Jan., '45.

Seamless Tubing Tolerances.....12

Tube Reducing Corp., Wallington, N. J., offers booklet containing technical data on production and uses of tube stock made by "Rockrite" process, also discusses new, closer o.d. and i.d. tolerances, wall thicknesses, and bore concentricities stated obtainable by this process. New tapered tubing is also discussed.—AVIATION, Jan., '45.

Glass Tubing 13

Precision-bore glass tubing obtained by "Glo-Tech" process (tolerances of plus-minus 0.0002 in.) is described in booklet from Fischer & Porter Co., Hatboro, Pa. An extensive range of sizes and lengths is available.—AVIATION, Jan., '45.

Welding Applications 14

Resistance Welding at Work (Bulletin WP-44) from Progressive Welder Co., Detroit, contains 60 pages on resistance welding applications in text and illustration. It is intended as guide to variety of uses of process and as an aid in solving problems.—AVIATION, Jan., '45.

Flexible Metal Hose.....15

Booklet from Chicago Metal Hose Corp., Maywood, Ill., *Flexible Metal Hose For Every Industrial Use*, describes and gives specifications for company's various types of metal hose.—AVIATION, Jan., '45.

Low Temperature Brazing.....16

Bulletin No. 29 from Handy & Harman, New York City, points out how "Sil-Fos" and "Easy-Flo" silver brazing alloys can be used to simplify and speed up brazing operations.—AVIATION, Jan., '45.

Brazing Fluxes 17

Brazing, welding, and soldering fluxes are described in new catalog from Superior Flux Co., Cleveland, and characteristics of each are given.—AVIATION, Jan., '45.

Fire Extinguishing Equipment.....18

Line of dry chemical fire extinguishing equipment is described in catalog from Dugas Engineering Corp., Marinette, Wis. Listed are characteristics of approved hand extinguishers.—AVIATION, Jan., '45.

Hydraulic Devices 19

Bulletin No. 137 from Lyon-Raymond Corp., Greene, N. Y., offers engineering services in development of hydraulic devices for specific applications. Presses, loaders and stackers, and elevating turntables are illustrated.—AVIATION, Jan., '45.

New Fire Fighting System.....20

American-LaFrance-Foamite Corp., Elmira, N. Y., offers information on "Broamite" system of fire extinguishing for aircraft, employing methyl bromide

AVIATION READER'S SERVICE

JANUARY 1945

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49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64		
NEW PRODUCTS					65	66	67	68	69	70	71	72	73	74	75	76	77
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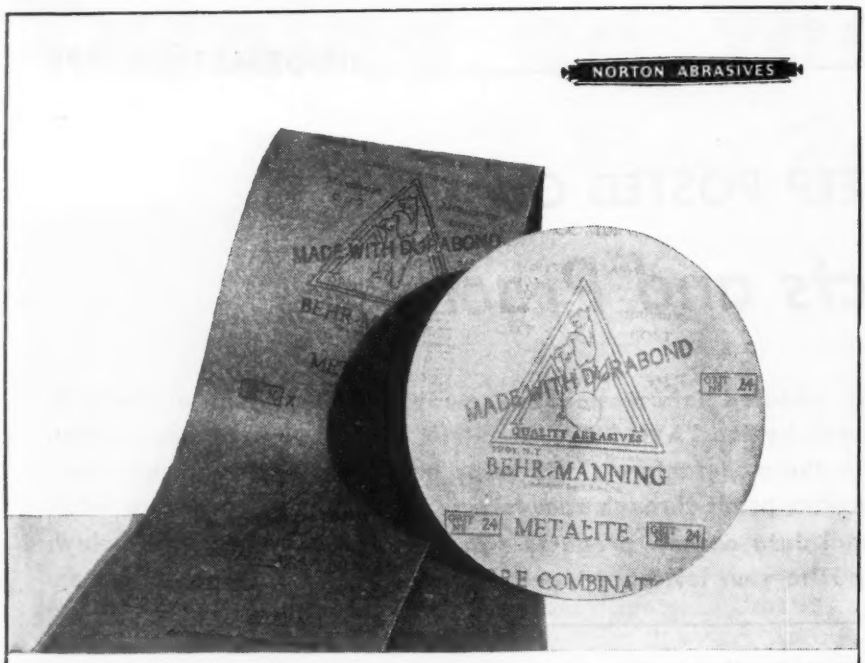

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LONGER, COOLER CUTTING LIFE

This latest Behr-Manning development, which hardens the adhesive bond, makes our metal sanding abrasives

More resistant to heat
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A bond that resists heat gives more rigid support to the millions of cutting grains and also greatly retards any tendency to "load."

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"DURABONDED" Coated Abrasives bring you both these fundamental advantages.

Reports from hundreds of metal sanding operations in the field—on high speed belts, discs and "gadgets"—show an average of 20% increase in cutting life at no advance in price.

If you have not yet tried "DURABONDED" abrasives, use the coupon and one of our Field Engineers will arrange for working tests on any jobs you select.

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(DIVISION OF NORTON COMPANY)

BEHR-MANNING, TROY, N. Y.
We would like to know more about "DURABONDED" Coated Abrasives.
Firm Name ..... Street .....
City ..... Zone ..... State .....
By ..... Title .....

as agent, designed to save weight and insure efficiency at extreme temperatures or altitudes.—AVIATION, Jan., '45.

Milling Cutter Data 21

Milling Cutter Data is title of catalog from Barber-Colman Co., Rockford, Ill., giving description and specifications of company's machines and cutters, also detailing a number of case histories indicating production savings.—AVIATION, Jan., '45.

Clark Products Catalog 22

Vest pocket booklet from Clark Equipment Co., Buchanan, Mich., describes line of drills and reamers, steel castings, metal spoke wheels, transmissions, gears, forgings, and other items.—AVIATION, Jan., '45.

Tapping Machine 23

"Tapmaster," new 3-spindle automatic tapping machine, is described in circular from D. H. Prutton Machinery & Tool Co., Cleveland. Feature is ability to tap three different sized holes up to 1 in. simultaneously.—AVIATION, Jan., '45.

One Hand Extinguisher 24

New carbon dioxide fire extinguisher, made by Randolph Laboratories, Chicago, requires only one hand to operate. Circular describes it as having self-aimed discharge horn and thumb-operated trigger valve.—AVIATION, Jan., '45.

Level Float Control 25

Hancock Valve Div., Manning, Maxwell & Moore, Bridgeport, Conn., announces catalog describing electric level float control, designed to give accurate liquid level with freedom from mechanical trouble.—AVIATION, Jan., '45.

Coolant Separator 26

Bulletin 151-A from Barnes Drill Co., Rockford, Ill., describes magnetic-automatic coolant separator embodying new method stated to remove metal and abrasive particles from honing coolants having non-soluble base.—AVIATION, Jan., '45.

Re Carbide Tools 27

New catalog describes tantalum-tungsten carbide tools and blanks offered by Vascoloy-Ramet Corp., North Chicago, Ill. Latest model tools and additional sizes are covered.—AVIATION, Jan., '45.

MACHINERY & ACCESSORIES

Vibration Dampener 28

Booklet from Hamilton Kent Mfg. Co., unit of U. S. Stoneware, Akron, Ohio, describes new type of vibration mount for machinery, utilizing vibration dampening properties of rubber in shear, but stated to obviate possibility of overloading shear elements.—AVIATION, Jan., '45.

Air Gaging 29

Circular No. 479 from Pratt & Whitney, Div. Niles-Bement-Pond Co., West Hartford, Conn., contains descriptions of "Air-O-Limit" gages of various models, explanations of their uses. Scale layouts are included.—AVIATION, Jan., '45.

Multiple Machining 30

Bullard Co., Bridgeport, Conn., announces new Type DF twin-6 and twin-8 spindle "Mult-Au-Matic" chucking machines, former having 10 stations and latter 14 stations. Capacity is in 8-in. class of work where boring, turning, facing, drilling, and reaming are required.—AVIATION, Jan., '45.

Prefabricated Jigs 31

Information is offered on "Borlocator" system for use in assembling wide variety of production and inspection jigs and fixtures. It consists of set of 150 precision components, including master location plates that can be assembled to conform to any layout by means of special locking clamps and screws. Combinations of drill jig bushings, drill bushing adapters, and lock screws are mounted on location plate according to center distances of holes to be drilled. Maker is Steel Tools, Inc., Cleveland.—AVIATION, Jan., '45.

Hydraulic Equipment 32

Bulletin 130-A from Watson-Stillman Co., Roselle, N. J., describes hydraulic

equipment offered by company, including valves and fittings, presses for powdered metal, injection molding, extrusion and other uses, pressure pumps, accumulators, and hand pumps.—AVIATION, Jan., '45.

Carbide Tipped Tools 33

Metro Tool & Gage Co., Chicago, offers circular describing line of carbide tipped tools for use in turning, facing, and boring operations on steel, cast iron, bronze, aluminum, and non-metallics.—AVIATION, Jan., '45.

Testing Machines 34

Hydraulic machines for impact, tension, compression, transverse, and hardness testing are described in illustrated circular from Riehle Div., American Machine & Metals, East Moline, Ill.—AVIATION, Jan., '45.

Boring, Drilling and Milling.....35

"Dreadnaught" horizontal boring-drilling-milling machines, both floor and table type, are described in new catalog from Ohio Machine Tool Co., Kenton, Ohio. Made in 5- and 6-in. dia. spindle models, machines are designed to handle both large and heavy work.—AVIATION, Jan., '45.

Deburring and Finishing.....36

Slash Time and Cost With Roto-Finish is title of circular from Sturgis Products Co., Sturgis, Mich. It describes new method of grinding, de-burring, polishing, honing, and coloring, stated to give new uniformity and economy.—AVIATION. Jan., '45.

Lift Truck Bulletin.....37

New bulletin featuring automatic transporter platform and pallet type motorized hand lift trucks for industry is announced by Automatic Transportation Co., Chicago. Details of operation, specifications, and applications are given.—AVIATION, Jan., '45.

Lever Operated Chuck.....38

Monarch Governor Co., Detroit, offers new circular describing four standard setups on "Jiffy-Jig", lever-operated chuck for drilling, milling, boring, and grinding.—AVIATION, Jan., '45.

Adjustable Cutting Tools.....39

Catalog No. 44 from Robert H. Clark Co., Beverly Hills, Calif., contains specifications and descriptions of line of adjustable cutting tools, including tool holders, hole cutters, counterbores, face milling cutters, and grinding fixtures.—AVIATION, Jan., '45.

Infra-Red Equipment 40

Circular from Fostoria Pressed Steel Co., Fostoria, Ohio, has as topic company's industrial lighting and industrial radiant energy service, designed to aid industry in infra-red testing and selection of equipment.—AVIATION, Jan., '45.

Aircraft Hand Tools.....41

Large combination reference manual and catalog of small hand tools for aircraft production and maintenance is offered by Aircraft Tools, Inc., Los Angeles. Much useful engineering data is included in this 178-page publication.—AVIATION, Jan., '45.

High Speed Tool Manual.....42

Operators manual from Black Drill Co., Cleveland, contains revised tables on speeds recommended for drilling hardened steels, amplified instructions on correct procedure for wet and dry drilling, and comprehensive information on application of "Hardsteel" in tool bits and tips used in machining tough steels and abrasive copper and aluminum alloys.—AVIATION, Jan., '45.

Tangent Bender 43

Described as handling practically all work that can be formed on double wing tangent bender, except certain heavy duty jobs, new single wing tangent bender offered by Struthers Wells Corp., Titusville, Pa., is described in Bulletin No. 57-T.—AVIATION, Jan., '45.

Vacuum Equipment 44

Folder from Invincible Vacuum Cleaner Mfg. Co., Dover, Ohio, discusses advan-

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tages of company's equipment for plant and office cleaning and removal and reclaiming of material.—AVIATION, Jan., '45.

Measuring Instruments 45

Measuring instruments and controls made by Leeds & Northrup Co., Philadelphia, are described in catalog just issued. Contained are sections covering instruments for measuring by each of four pyrometric methods; heat-treating furnaces; and laboratory devices.—AVIATION, Jan., '45.

Air Controlled Devices.....46

Portfolio of 25 photos from Bellows Co., Akron, Ohio, illustrates and describes installations of company's air controlled devices in various plants—air motors, air feeds, air vices, air collets, etc.—AVIATION, Jan., '45.

Grinding and Finishing.....47

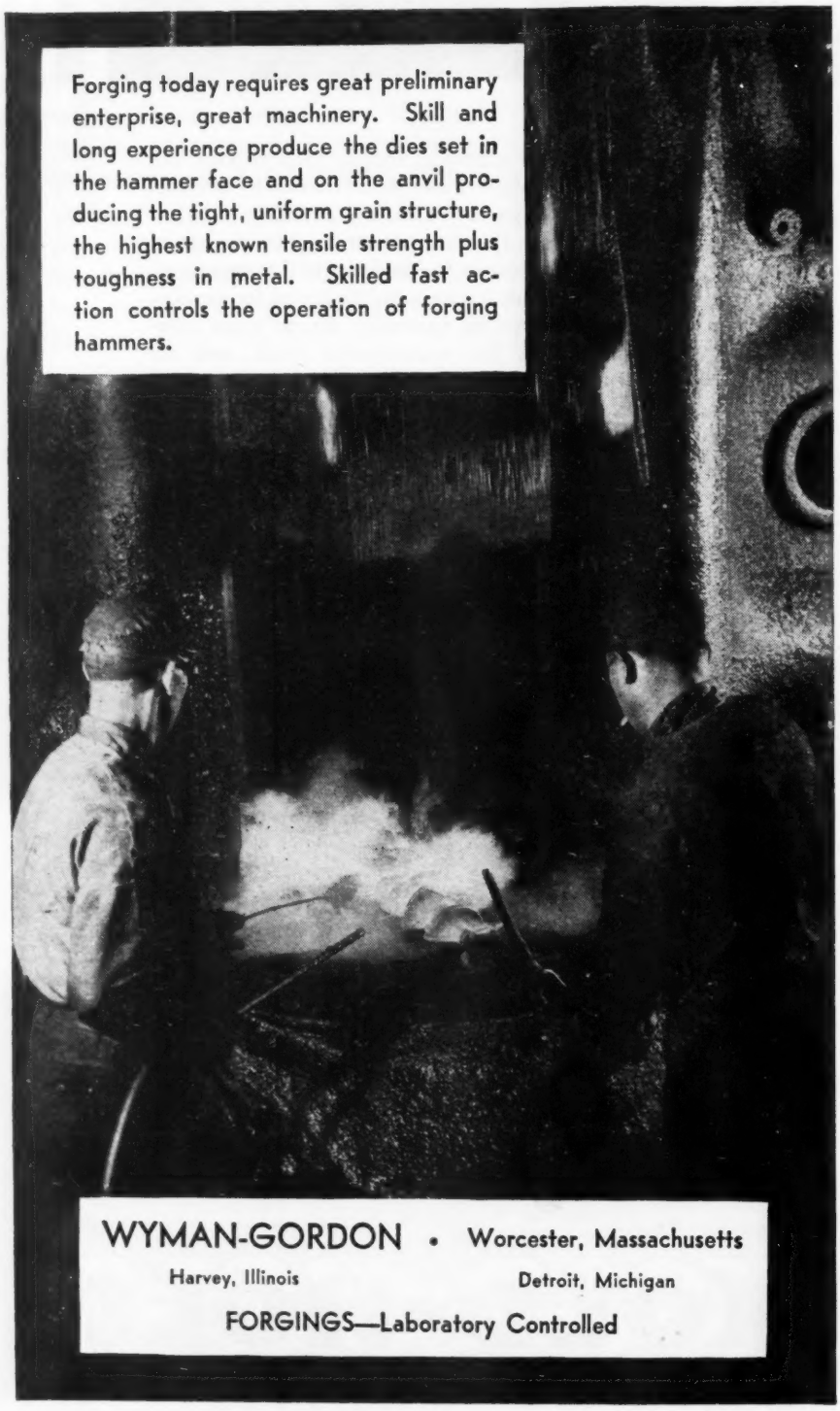
New booklet titled *Step Up Production With the 3-M Method of Grinding and Finishing* is issued by Minnesota Mining & Mfg. Co., St. Paul, Minn. It is addressed to purchasing agents, works and production managers, chief engineers, and plant superintendents.—AVIATION, Jan., '45.

Acetylene Generators 48

Describing line of generators, circular from Air Reduction Co., New York City, features new type "P" portable generator which incorporates an air-lift water circulating system.—AVIATION, Jan., '45.

Air Operated Tools.....49

Airop, Inc., Dearborn, Mich., has issued folder showing applications and principal features of its line of air operated devices used in connection with milling, riveting, welding, drilling, and reaming operations. —AVIATION, Jan., '45.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FORGINGS—Laboratory Controlled

PLASTICS

Plastic Coating 50

Technical information on No. 23 "Amercoat" plastic coating made by Amercoat Div., American Pipe & Construction Co., Los Angeles, describes general, physical, and chemical properties. — AVIATION, Jan., 45.

Ethyl Cellulose 51

Hercules Powder Co., Wilmington, Del., has issued technical booklet, *The Properties and Uses of Ethyl Cellulose*, describing product's low flammability, freedom from discoloration by sunlight, toughness, flexibility, heat resistance, and usefulness in formation of plastics. — AVIATION, Jan., '45.

ELECTRICAL

Electronic D.C. Supply.....52

Bulletin GEA-4317 from General Electric Co., Schenectady, N. Y., describes new line of metal-enclosed, high voltage d.c. power supply units, rated up to 50,000v. d.c., providing source of d.c. power for electronic applications.—AVIATION, Jan., '45.

Relays and Solenoids.....53

Guardian Electric Mfg. Co., Chicago, has issued circular giving operating characteristics on eight relays and eight solenoids.—AVIATION, Jan., '45.

Transformer 54

Bulletin No. 12Cv-105 from Sola Electric Co., Chicago, gives electrical and mechanical specifications of hermetically sealed constant voltage transformer for through-chassis mounting, designed for electronic gaging and inspection equipment and for other applications where precisely regulated supply voltage is mandatory.—AVIATION, Jan., '45.

Electric Arc Welding.....55

Working Principles of Electric Arc Welding is title of booklet from Harnischfeger Corp., Milwaukee. Technical and practical information on arc welding, also principles and advantages are offered.—AVIATION, Jan., '45.

Electric Time Delay Relay.....56

Handbook of instructions on "Agastat", electro-pneumatic time-delay relay for introducing time delay in electrical circuits, is offered by American Gas Accumulator Co., Elizabeth, N. J.—AVIATION, Jan., '45.

Solderless Wiring 57

Bulletin No. 33 from Aircraft-Marine Products, Inc., Harrisburg, Pa., contains details of design possibilities in simplified wiring systems, and each item in company's line is detailed.—AVIATION, Jan., '45.

Thermocouple Data 58

Bulletin S2-5 is new edition of thermocouple data book issued by Wheelco Instruments Co., Chicago. Included are descriptions and recommendations.—AVIATION, Jan., '45.

Radio Compass 59

Radio Div., Bendix Aviation Corp., Baltimore, has issued booklet titled *The Radio Compass*. Comprehensive information on device is given—AVIATION, Jan., '45.

Communication Equipment 60

Information and specifications are available, in circular and catalog form, from Federal Telephone & Radio Corp., Newark, N. J., concerning company's dual cables, coaxial cables, radio transmitters, multicontact switches, transformers, and rectifiers.—AVIATION, Jan., '45.

Starting Switch 61

New split-phase motor starting switch for split-phase, "capacity start-induction run", and "capacity start-capacity run" motors, is described in circular from Motor Controls Div., Borg-Erickson Co., Chicago.—AVIATION, Jan., '45.

Magnetic Strength Tester.....62

Circular from Hickok Electrical Instrument Co., Cleveland, describes new electronic fluxmeter designed for testing magnetic strength.—AVIATION, Jan., '45.

Electrical Assemblies 63

Photographs of various types of electrical assemblies for aircraft industry, also special section on company's aluminum junction boxes, are included in booklet from Union Aircraft Products Co., New York City.—AVIATION, Jan., '45.

Cable Connections 64

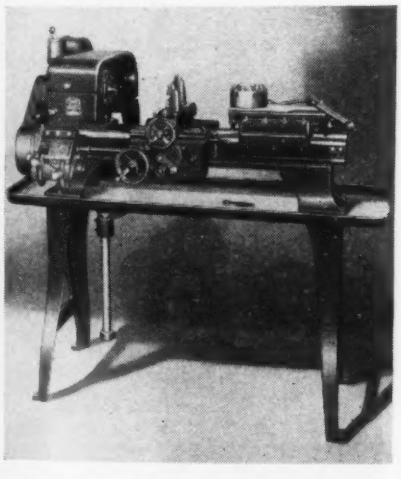
Electrode holders, ground clamps, cable connectors, machine terminals, and cable lugs are described in new catalog from Tweco Products Co., Wichita, Kan.—AVIATION. Jan.. '45.

NEW PRODUCTS

Latest Machine Tools

Turret Lathe..... 65

Features of No. 840 quick change gear turret lathe made by **Logan Engineering Co.**, Chicago, include: Precision preloaded ball bearing spindle mounting adjustable gibs, and self lubricating bronze bearings. Machine handles bar stock up to and including ⅝ in. Gear box provides 48 threads and feeds in either direction. Adjustments of two levers provides for



making screw threads of from 8 to 224 per in., and by changing 24-tooth stud gear for 48-tooth stud gear, additional threads of 4 to 7 per in. are accessible. Similarly attainable are longitudinal power feeds from .0015 to .1000 in. per revolution on spindle. Power cross feeds are .25 times longitudinal feeds. Automatic apron operates from spline in lead screw through worm-drive friction clutch for both longitudinal and cross feeds. For cutting threads, additional longitudinal drive operates from half nuts on lead screw.—**AVIATION, Jan., '45.**

Internal Gear Checker..... 66

Designed to check tooth spacing, eccentricity, pitch dia., and root dia. of spur or helical gears from 3 to 64 diametral pitch and from 2 to 18 in. pitch dia., new internal gear checker has been developed by **National Broach & Machine Co.**, Detroit. Checking-head spindle, at right angles to work spindle, is adjustably spring loaded to advance it toward work gear teeth, and spindle is retracted by hand lever. Forward end of checking-head spindle carries rigid ball-pointed contact finger and movable pivot finger which actuates spindle of a .0001 indicator on which errors in tooth spacing or index are read. Rear end of same spindle carries arm which contacts spindle of .0005 in. indicator on top of

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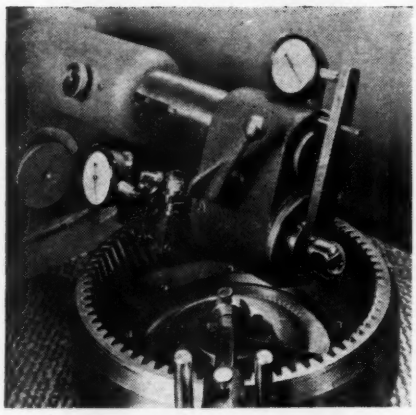
checking head to register axial movement of checking-head spindle in measuring eccentricity errors of pitch dia. and root dia. Adjustable gear tooth locator positions work gear with reference to ball-point contact finger and prevents skipping a tooth when indexing work gear. To check index, checking-head spindle is advanced to bring ball-point finger in contact with gear tooth at pitch line. Pivot finger is then adjusted to contact adjacent tooth similarly and indicator is set at zero. Checking-head spindle is then retracted while work gear is indexed one tooth and then advanced to contact second pair of teeth. Any change in position of pointer represents a difference in spacing. Each pair of teeth are likewise checked, unless only a partial investigation is desired. Eccentricity and index can be checked at same time. After index fingers are set on first pair of teeth, pointer of upper dial indicator is brought to zero. As each succeeding pair of teeth is checked, pointer registers



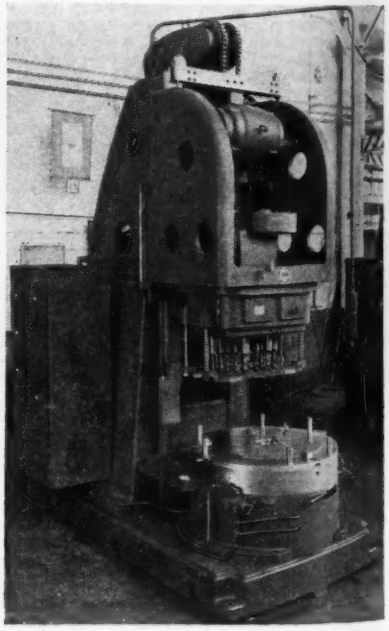
eccentricity. Pitch dia. is checked by comparison with gear of known size. Root dia. and eccentricity of root circle is checked independently by substituting contact finger with conical point. Photo shows close-up of checking mechanism.—**AVIATION, Jan., '45.**

Straightening Press..... 67

Developed for straightening both finished and rough work, new line of hydraulically operated straightening presses is announced by **Colonial Broach Co.,** Detroit. Presses have built-in motor and hydraulic cylinder. Control is through hand and foot pedals, and gage indicates exact pressure. Fixtures are equipped with either center or roller-type work supports mounted on long guide rail through free action rollers. Capacity ranges up to 50 tons.—**AVIATION, Jan., '45.**

Heavy Duty Drill..... 68

Designed for heavy duty single or multiple spindle drilling, boring, reaming, or milling operations, No. 540 vertical hydraulic feed machine is announced by **Defiance Machine Works,** Defiance, Ohio. Machine is provided with automatic cycle of rapid approach, adjustable feed, and rapid return to stop. Cycle can be arranged with dwell at end of feed. Head is driven through multiple V-belt and provided with one pair of pick-off change gears to give speed of from 200 to 500 rpm. at power takeoff. Machine illustrated has 28-spindle head and fixture for drilling 11/16 in. holes in large dia. plates ¾ in. and ⅝ in. thick. For this operation, machine has 42-in. three-station indexing table. Table has ball thrust bearing on end of trunion bearing, and each time index pin is disengaged, table is raised slightly by lifting device, this device and index pin being controlled by hydraulic cylinder. Motor is 25-hp.,



1,800-rpm. unit; distance of spindle to face of column is 26 in.; feed cylinder is 7½ in.; stroke of head 20 in.; head guide length on column 60 in.; over-all width of ways on column 28 in; base 60 x 118 in.; and weight 39,150 lb.—**AVIATION, Jan., '45.**

Gear Finishing Machine..... 69

Made by **Michigan Tool Co.,** Detroit, new "postwar" line of Series 900 rack-type crossed-axis gear finishing machines features improvements. Completely hydraulic, new units incorporate 2 separate hydraulic systems, one for operation of table and one for head feed. Lubricants and coolants have separate outlets, and automatic lubrication has been extended to rack table ways, which are hardened and ground dovetail. Control system is stated to be improved. During cutting cycle, work is reciprocated at a predetermined rate of speed across rack while rack reciprocates longitudinally in mesh with work. Controls of both speeds are

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ANNOUNCEMENTS—

of new machine tools, shop equipment and materials, electrical appliances, and aircraft parts and accessories are invited for inclusion in these columns.

In writing, emphasis upon specific aviation applications of newly-marketed items is desirable.

Manufacturers should address New Products Editor, AVIATION, 330 W. 42nd St., New York City 18

adjustable; also a counter regulates number of finishing strokes desired after vertical feed has been completed to bring work to correct size on pitch dia. Control buttons, stations, etc., operate on 110 rather than power-line voltage. Machine is designed to finish gears up to 8 in. dia. with max. length between centers of 18⅛ in., and is stated to permit pre-compensating for heat-treat distortion.—AVIATION, Jan., '45.

Toolroom Lathe..... 70

South Bend Lathe Works, South Bend, Ind., announces new 9 in. tool room lathe with 9¼ in. swing and 22 in. between centers, and with max. collet capacity of ½ in. and ¾ in. spindle bore. Afforded are 12 spindle speeds ranging from 41 to 1,270 rpm., with back-gear drive for lower speeds. Quick change gear box permits cutting of 48 pitches of screw threads, 4 to 224 per in., and provides 48 power longitudinal feeds and power cross feeds.—AVIATION, Jan., '45.

Shop Equipment & Materials

Tool Bits..... 71

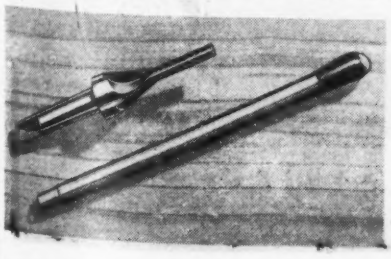
New alloy, "Borcoloy" (combination of basic alloy and boron and cobalt) is employed in tool bits developed by **General Aircraft Equipment Co.,** South Norwalk, Conn. Grade 5, with 12 percent cobalt, is recommended for heavy duty cutting on high alloy steels, heat-treated bar stock, or forgings, this grade being used for solid bits only. Grade 6, with 20 percent cobalt, is to be used for rough turning work and fine finishing at high speeds, and it is available in both solid bits and tipped tools.—AVIATION, Jan., '45.

Masking Tape..... 72

Die cut to any size or shape desired is masking tape manufactured by **Paper Novelty Mfg. Co.,** Brooklyn, which states tape resists high temperatures and has easily removed backing.—AVIATION, Jan., '45.

Form-Ground Cutting Tools..... 73

Featured in line of cutting tools, form ground with cam relief, are new standard gear tooth pointers and special tools ranging in size from 1⅛ in. dia. to very small reamer (shown in illustration contrasted with ordinary match stick). Made by **Gay-Lee Co.,** Detroit, line also includes gear-rounding and chamfering cutters and clutch tooth milling cutters. —AVIATION, Jan., '45.



Variable Contours Cutter..... 74

Turchan Follower Machine Co., Detroit, announces attachment described as permitting machining, on a lathe, of curved surfaces of variable contours. Master pattern or template is used as guide.—AVIATION, Jan., '45.

Carbide Tools and Holders..... 75

Extension of line of carbide tool holders and carbide tipped cutters is announced by **Armstrong Bros. Tool Co.,** Chicago. Holders are available with "straight", "right-hand offset", or "left-hand off-set" shanks, each in seven sizes; and cutters are tipped with two grades of carbides—"Armide" red for machining steel and "Armide" gray for cast iron, brass, bronze, aluminum, and non-metallics.—AVIATION, Jan., '45.

Rubber-to-Metal Glue..... 76

Applicable to aircraft installations, new glue (or adhesive) developed by **Firestone Tire & Rubber Co.,** Akron, Ohio, is described as being capable of bonding synthetic rubber to metal, including aluminum, without brass-plating, also to be impervious to water spots or rust film. —AVIATION, Jan., '45.

Screw Machine Stock Tubes..... 77

Engineered acoustically, screw-machine stock tubes made by **Corlett-Turner Co.,** Chicago, are described as eliminating banging and clattering of bar stock. Tubes can be installed on most standard stock stands.—AVIATION, Jan., '45.

Tests Propeller Governors..... 78

Designed for experimental or service testing of various types of governors, new automatic push-button controlled test machine has adjustable lever which pro-

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It isn't often that an idea created in the minds of boys will materialize in later life. With the five Turner brothers, William*, Cort, Frank, Charles and Robert, their boyhood idea that some day they would be in business together, overshadowed all the obstacles of hard work and study to make this idea a reality. Finally in April, 1939, they purchased their first grinding machine and formed their own company. From this modest beginning they gradually won recognition among manufacturers for precision-built gauges. This recognition made expansion necessary, and today their company occupies one of the most modern buildings for the manufacture of gauges in the country. The TG stamped on a gauge represents a product backed by the integrity of five brothers and their practical knowledge of precision gauges.

*William Turner, of the U. S. Navy, was killed in action in the Coral Sea Battle.

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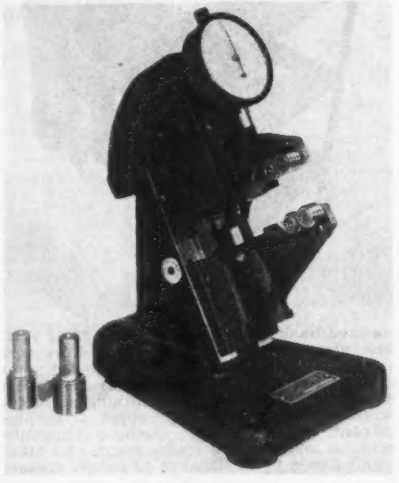
vides variable speeds at variable displacements to simulate flight conditions, also feathering system identical to that of aircraft system. Automatic electro-hydraulic controls are interlocked. Single selector switch sets entire machine for all test requirements. Internal leakage is indicated automatically. Machine has voltage regulator for electric head governors, also percentage meter for indicating hunting or wandering conditions. Total of 7½ hp. is available. Maker is Greer Hydraulics, New York City.—AVIATION, Jan., '45.

Pressure Control Comparator 79

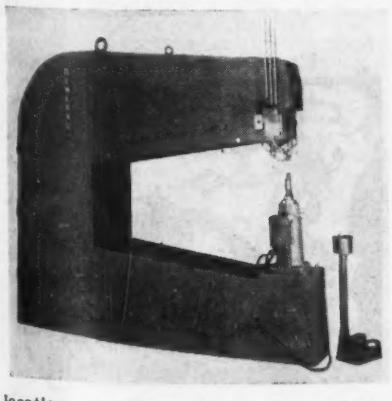
New roll thread comparator with pressure control is announced by Pratt & Whitney, Div. Niles-Bement-Pond Co., West Hartford, Conn. Principle is same as in company's snap gages, but combined is dial indicator pressure control on both sets of rolls. As work passes between "go" rolls, any movement of pointer



means an oversize thread. Photo shows gage with "go" and "not go" setting plugs. If thread is correct, pointer must move as work contacts "not go" rolls. Comparator consists of rigid base casting and main frame carrying indicator bracket. Frame carrying upper rolls contacts indicator and is supported by means which provide for vertical motion. Lower rolls are supported in frame which may be adjusted on its slide and locks in position. Vertical adjustable screw stop holds frames apart at exact setting with indicator at zero. Gage, adjustable from ¼ to 1½ in. dia., uses gaging pressure of approx. 2 lb. Indicator graduations are in .0001 in., which allows gage to be used for classifying.—AVIATION, Jan., '45.

Riveting Machine 80

Called "Drivmatic," new machine manufactured by General Engineering Co., Buffalo, is described as automatically performing four operations—drilling, countersinking, selecting, feeding, and heading rivets—with one depression of foot switch. Work can be stopped at any point of drilling operation and cycle restarted. All operations are through electrical interlocking, so that machine stops if any part fails to reach its proper



location on time. A 4-point selector switch enables operator to choose any single operation or multiple operations.—AVIATION, Jan., '45.

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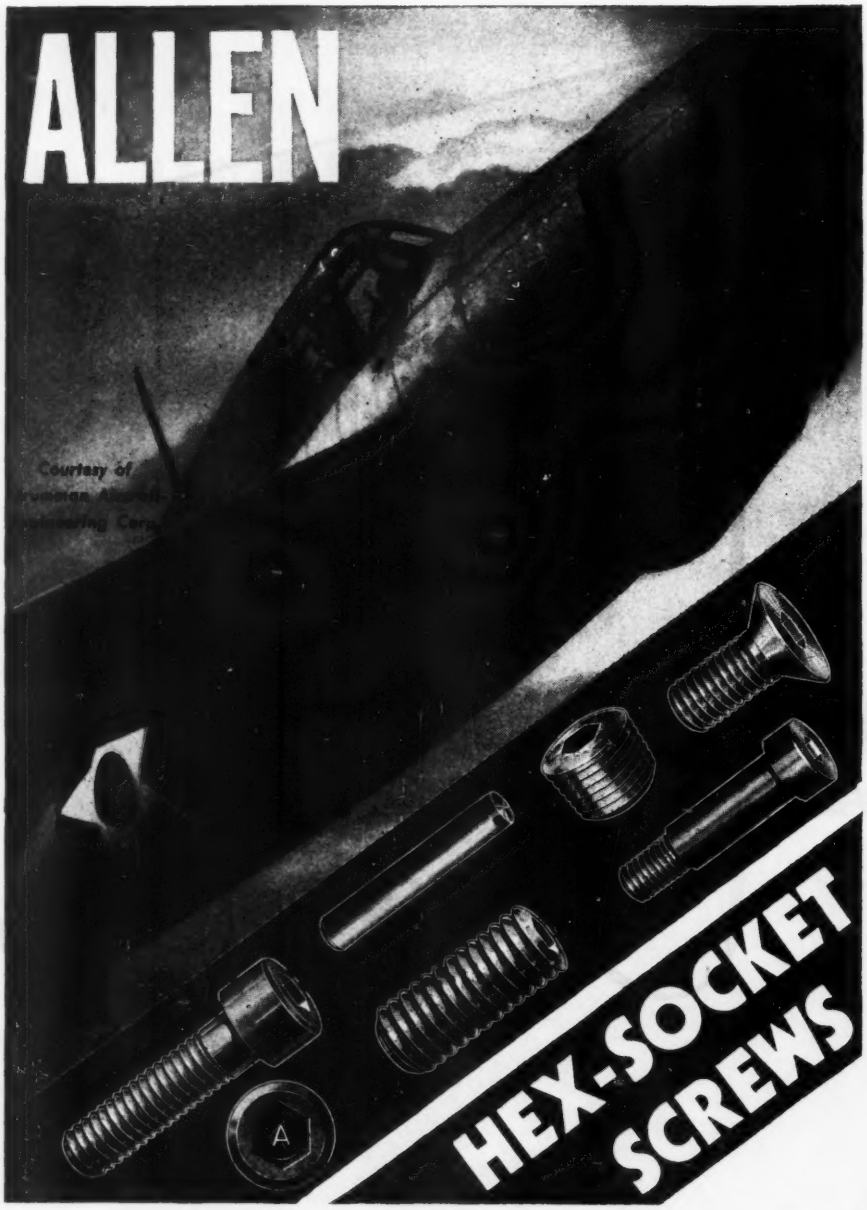

Lives hang by threads aboard aircraft, — the screw-threads that hold together the component parts. And the screws most famous for HOLDING-POWER are those most favored for mechanical assemblies where hollow screws are used in plane or plant.

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THE ALLEN MANUFACTURING COMPANY
HARTFORD, ★ ALLEN ★ CONNECTICUT, U.S.A.

Ball Bearing Cleaner 81

L & R Mfg. Co., Arlington, N. J., has produced new ball bearing cleaning machine combining rotary principle with new pressure cleaning mechanism. In rotary

cleaner basket, 50 to 100 bearings of various sizes are pre-cleaned. In pressure cleaning tank, continuously filtered solution under 6 to 10 lb. pressure is forced through each bearing individually. Filtered compressed air removes surplus solvent. With minor changes, machine may be adjusted to clean gears and other small assemblies. Basket of rotary cleaner is 5½ in. i.d. by 3⅜ in. deep. Total weight of machine is 200 lb., and unit operates on 110v. a.c. current.—AVIATION, Jan., '45.

Self-Locking Nut 82

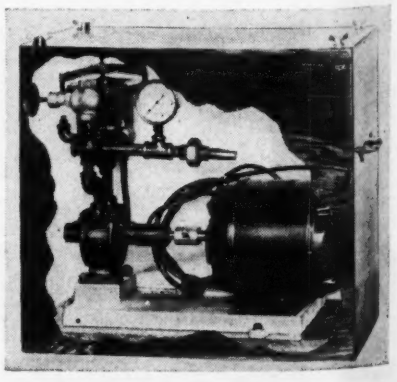
Dzus Fastener Co., Babylon, N. Y., announces development of new self-locking nut described as bringing improvement in precision fastening and means for keeping nut in place. Nut, which is all-metal, has feature which enables it to hold at any desired point.—AVIATION, Jan., '45.

Steel Straight Edges 83

Line of steel straight edges of suitable proportions, hardened, drawn, and accurately ground straight and parallel, and made in six sizes from 12 to 72 in., is announced by Taft-Peirce Mfg. Co., Woonsocket, R. I.—AVIATION, Jan., '45.

Portable Pressure Tester 84

Lightweight portable pressure and vacuum machines for air or gas testing or spot jobs are now available from Leiman Bros., Newark, N. J. Units will handle from 1 to nearly 5 cu. ft. of air and at pressure to around 10 lb. or 20 in. mercury vacuum. Machines can be made as light as 10 to 20 lb. and as small as 6 x 10 in., with interchangeable motors



for various currents, or to be direct-connected to motor shaft.—AVIATION, Jan., '45.

New Cutting Metal 85

Announcing cutting tools made from new type metal, **Jessop Steel Co.**, Washington, Pa., states that metal is cast nonferrous alloy made principally of chromium, tungsten, and cobalt with hardness range of from 60 to 62. Rockwell C. Tool is cast to shape and requires only surface grinding. Peak efficiency is stated to be realized at speeds 20 to 80 percent over top speeds for high speed steel. Flats or squares for tool holder bits or milling cutter inserts, with surfaces ground to tolerances of 0.000 and —0.005, can be supplied. Round sections are centerless ground to same tolerances. Die inserts, or other complicated sections, are furnished in as-cast condition.—**AVIATION, Jan., '45.**

Broken Drill Adapter 86

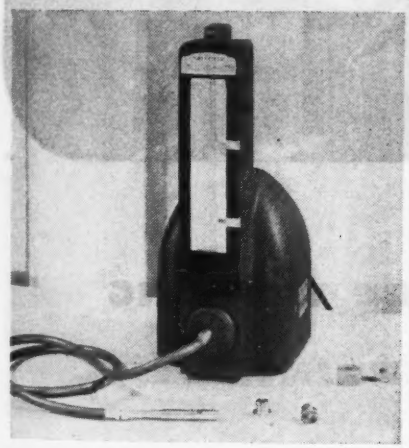
In new broken drill adapter made by **Topflight Tool Co.**, Towson, Md., drill fragment is inserted and through self-locking device becomes useful tool. Adapter is available in sizes to fit all drills.—**AVIATION, Jan., '45.**

Pressure Gage 87

Two types of spring-and bellows-actuated pressure gages, measuring ranges between 0 and 5 in. and 0 and 50 in. water, are available from **Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co.**, Philadelphia. One gage has single spring for pressure ranges; other has a second spring, in tandem with first, for vacuum and compound ranges. Application is to aircraft engine manufacturing, processing, testing, etc.—**AVIATION, Jan., '45.**

Internal Diameter Gage 88

New "Precisionaire" instrument made by **Sheffield Corp.**, Dayton, Ohio, provides amplification of 20,000 to 25,000 to 1 (a spread of 2 to 2½ in. per .0001 in.) on internal measuring. It is graduated in



.000005-in. increments. Instrument is stated to be extremely accurate in checking internal dimensions of fuel injection equipment having tolerance of plus-or-minus .000005-in. Model No. 600-0 is suitable for tolerances from .0002 in. to .000005 in. with amplification from 15,000 to 25,000 (a spread of 1½ to 2½ in. per .0001 in.)—**AVIATION, Jan., '45.**

Disk Grinders 89

Two models, regular and heavy duty, of new all-purpose disk grinder are offered by **Kindt-Collins Co., Cleveland.** Principal features: 30-in. disk with 26-in. high grinding area; all-hydraulic controls; position stop on protractor for stopping table in positions from 45 deg. down to 15 deg. up; ventilated table; and means for removing paper or cloth disks without removal of steel disk. Speed of disk is 800 rpm., giving rim speed of 6,260 fpm. Floor-space dimension, 41 x 38½ in.; height, 57⅝ in.; and weight, 2,100 lb.—**AVIATION, Jan., '45.**

Universal Chuck 90

Ideal Commutator Dresser Co., Sycamore, Ill., announces new universal 3-jaw chuck, scroll of which is made of alloy steel. Two sets of jaws (one for internal and other for external work) and mounting adapter are furnished.—**AVIATION, Jan., '45.**

Tubular Snap Gage 91

New tubular adjustable limit snap gage, described as light yet strong and less likely to expand or warp, is announced by **Tubular Micrometer Co.**, St. James, Minn. It is made of tubular steel, copper, nickel and chrome plated. Buttons are of tungsten high speed steel.—**AVIATION, Jan., '45.**

Measuring Parallelism 92

Acme Industrial Co., Chicago, announces development of new instrument designed to measure parallelism of seal rings and similar objects, also to determine change of parallelism under any desired pressure. Called "Parascope," this light-wave device may also be used for measuring comparative height of objects, such as balls for precision bearings. To measure parallelism, work is laid on an optical flat with another optical flat placed on top, and assembly is set on instrument table. Through eyepiece operator sees a number of bright and dark bands, each indicating change of separation of optical flat surfaces of approximately ten millionths of an inch. Out-of-parallelism in millionths is sum of bands multiplied by 10. In flatness check, curved bands indicate deviation from flatness. Instrument will measure work up to 6-in. dia. and ½-in. thick; other sizes can be accommodated by special arrangement. —**AVIATION, Jan., '45.**

New Safety Nut 93

New safety nut manufactured by **Simlok Fastener Div., Simmons Machine Tool Corp.**, Albany, N. Y., operates on principle of engagement of snap ring in one of a number of serrations in bolt thread. Design features 7 serrations to provide 14 locking positions per revolution of nut. Nut can be used, it is stated, on any length thread and is locked or unlocked by a flip of locking ring. Bolt serrations are cut with an internal broach-

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CINCINNATI . Front St. and Freeman Ave. Cherry 3232

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DETROIT ..... 1600 E. Euclid Ave.
CLEVELAND..E. 53rd and Lakeside Ave.
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BOSTON..3rd & Binney Sts., Cambridge

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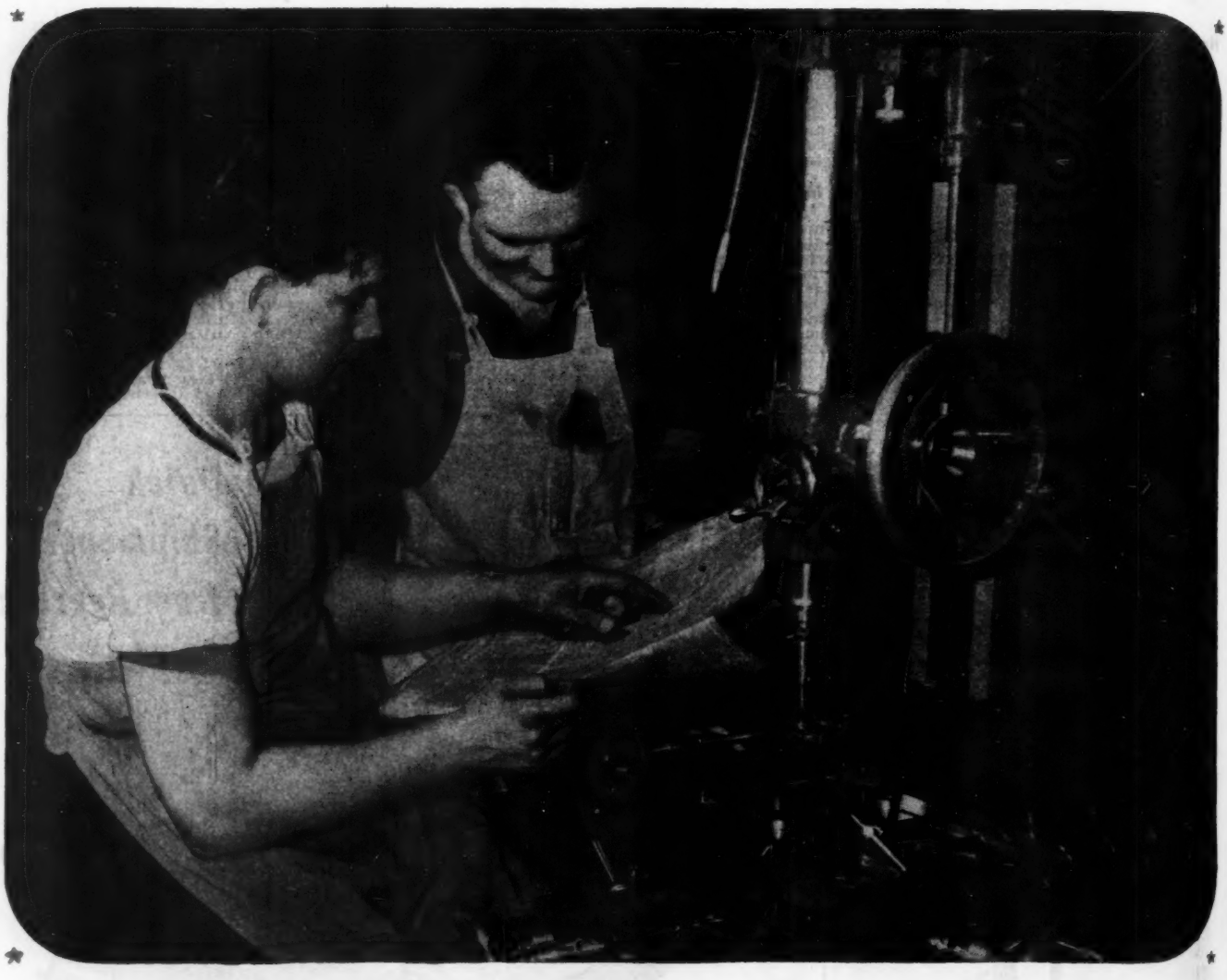

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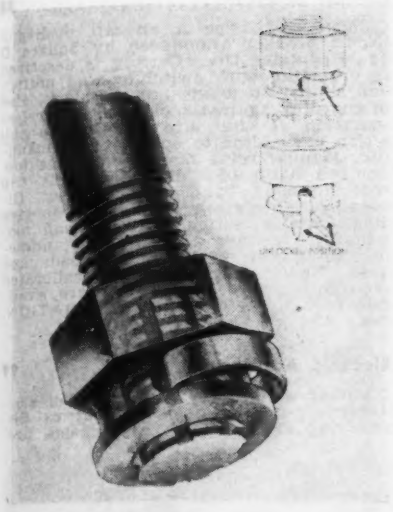
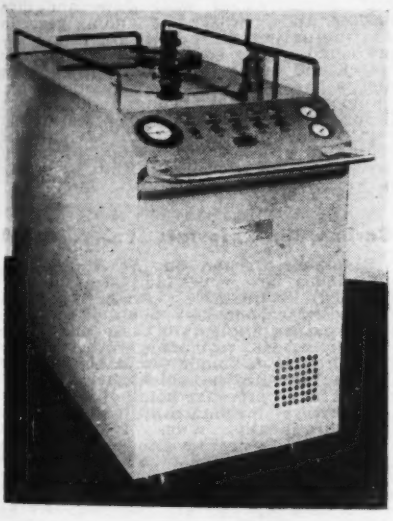


ing tool, which may be hand operated on pre-assembled parts. Used as stop nut, serrations are reported unnecessary since spring pressure of ring provides stopping action.—AVIATION, Jan., '45.

Corrosion-Proofing Engines..... 94

Equipment for "pickling" or corrosion proofing aircraft engines is announced by **Youngstown Miller Co.**, Sandusky, Ohio, which states that each unit is engineered to suit various specific requirements of



each type and size of engine. All carts are complete with motors, electric heaters, thermostats, controllers, pumps and filters, and heaters ranging from 9 to 125 kw.—AVIATION, Jan., '45.

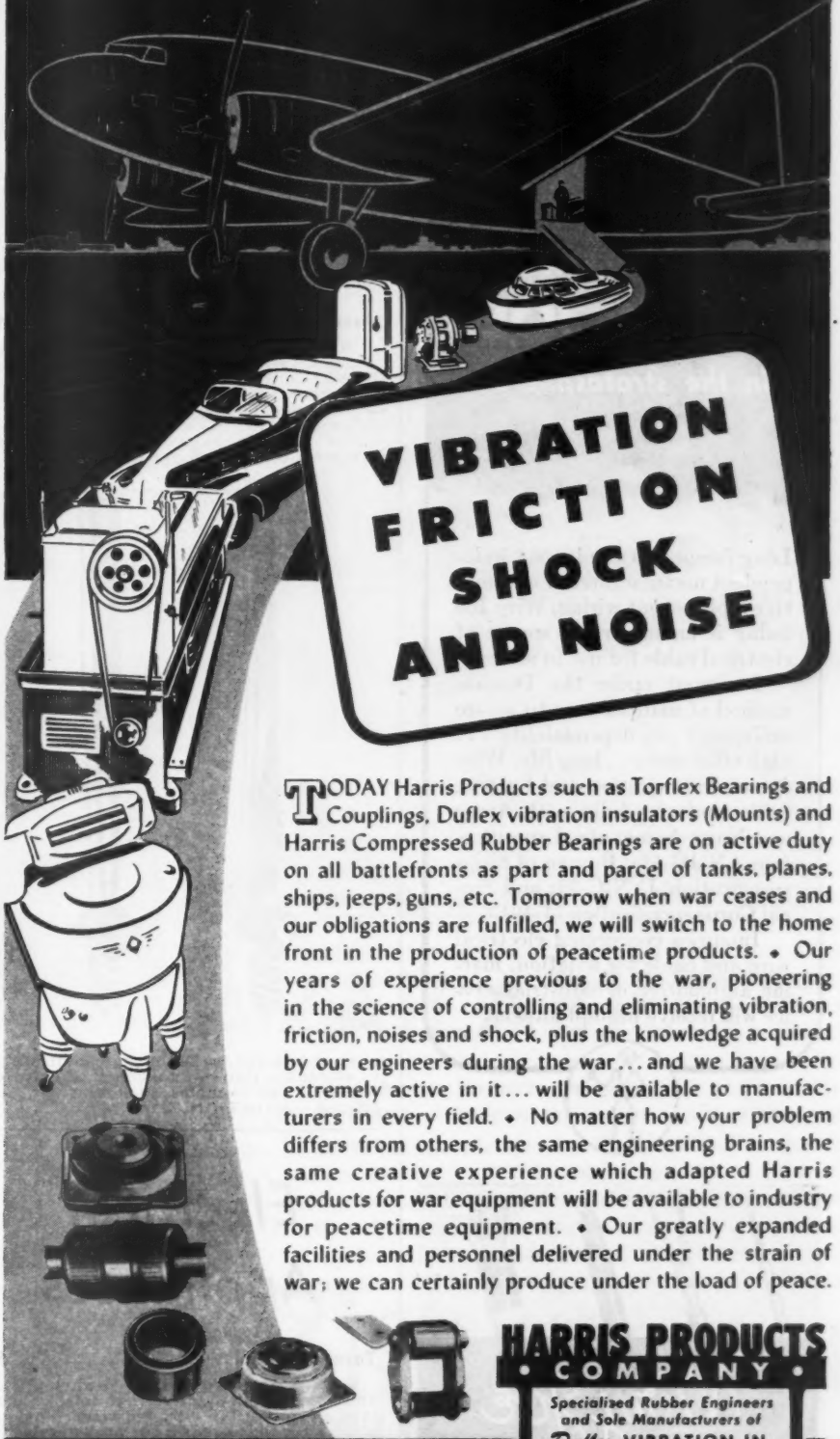
ANNOUNCEMENTS—

of new machine tools, shop equipment and materials, electrical appliances, and aircraft parts and accessories are invited for inclusion in these columns.

In writing, emphasis upon specific aviation applications of newly-marketed items is desirable, and whenever possible glossy-print photos should be enclosed. Please do not send electros.

Manufacturers should address New Products Editor, AVIATION, 330 W. 42nd St., New York City 18

TODAY is a Foretaste of Tomorrow in the Elimination of



VIBRATION FRICTION SHOCK AND NOISE

TODAY Harris Products such as Torflex Bearings and Couplings, Duflex vibration insulators (Mounts) and Harris Compressed Rubber Bearings are on active duty on all battlefronts as part and parcel of tanks, planes, ships, jeeps, guns, etc. Tomorrow when war ceases and our obligations are fulfilled, we will switch to the home front in the production of peacetime products. • Our years of experience previous to the war, pioneering in the science of controlling and eliminating vibration, friction, noises and shock, plus the knowledge acquired by our engineers during the war... and we have been extremely active in it... will be available to manufacturers in every field. • No matter how your problem differs from others, the same engineering brains, the same creative experience which adapted Harris products for war equipment will be available to industry for peacetime equipment. • Our greatly expanded facilities and personnel delivered under the strain of war; we can certainly produce under the load of peace.

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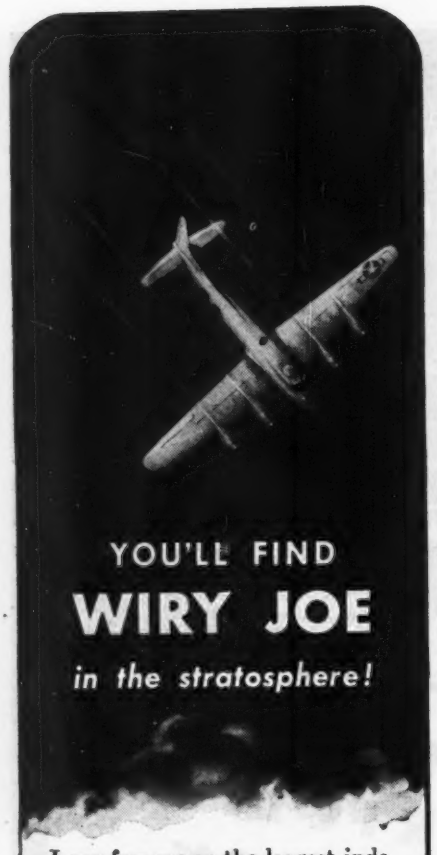

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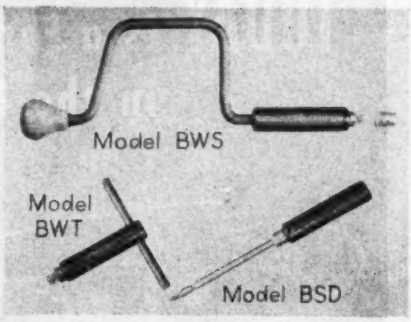
Torque Wrench **95**

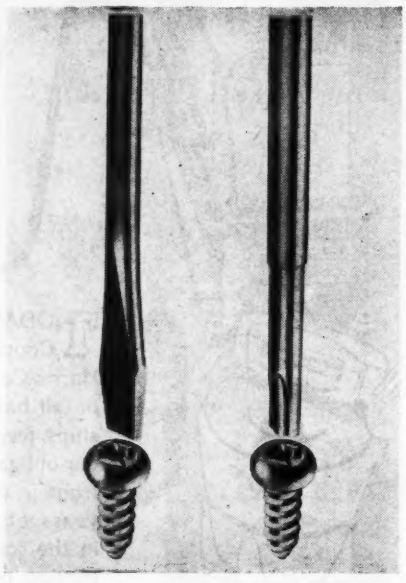
Crump Mfg. Co., Los Angeles, has developed new "Speed-Tork" wrenches de-



signed to torque both left and right hand nuts, bolts, and screws without readjustment. Featured is adjustment by 1 in./lb. from 1 to 60 in./lb., also sealed-in lubrication. Wrenches (see photo) are available with offset or sliding "T" handle and for standard ⅜-in. square drive or Phillips screw tips.—**AVIATION, Jan., '45.**

Assembly Line Screws **96**

"Clutch Head" assembly line screws, manufactured by **United Screw & Bolt Corp.**, Chicago, are described as being operative with an ordinary type screw driver (see photo) or any flat blade of correct width; to offer a lock-on with screw and bit as a unit for one-hand reaching to hard-to-get-at spots; and as



having straight walled engagement stated to eliminate ride-out tendency. Illustrated booklet, also samples including bit, are offered.—**AVIATION, Jan., '45.**

Electrical Appliances

Terminal Blocks **97**

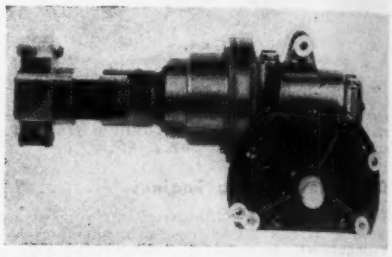
L. S. Brach Mfg. Corp., Newark, N. J., announces "Bee" terminal block, new type of solderless wire-to-wire connector strip affording practically any number of terminal posts made up in different arrangements, each post capable of handling from two to eight wires. Binding post stud has slotted channel, wires being held between top clamp or shoe built into nut, with lower clamp or shoe secured to base. Block is coated with hard moisture-proof arc-resistant film containing fungicidal substance. Base is made of laminated phenolic.—**AVIATION, Jan., '45.**

Circuit Breaker **98**

Class 9311 Type A aircraft push-pull circuit breaker announced by **Square D Co., Regulator Div.**, Detroit, is described as providing both switching and protection similar to toggle type breakers, also as guarding against accidental or careless operation of vital circuits. Definite pull action is required to open breaker manually. Manual reset button, black at top, has red hand to indicate daylight trip and luminous band for darkness. Bimetallic trip element is designed to give time-limit protection against small momentary overloads as well as instantaneous protection on heavy overloads and short circuits. Each breaker is calibrated and factory sealed. Breakers are available in 5 to 50 amp. sizes.—**AVIATION, Jan., '45.**

Electric Actuator **99**

Among application possibilities of electric actuators developed by **Electrical Engineering & Mfg. Co.**, Los Angeles, are:



For hub motors, doors, actuators for operating cowl flaps, driving of gun turrets, actuating of wing flaps and dive brakes, and operation of landing gear. In door-actuating unit a ⅛ hp. thermally-protected motor equipped with magnetic clutch and brake forms heart of compact and self-contained gear reduction unit. Compound planetary reduction of 478 to 1 is provided, with additional worm and sector reduction of 30 to 1, giving total reduction of 15,000 to 1. Max. torque on drive shaft is 6,000 in./lb. Unit is for use in 28v. system.—**AVIATION, Jan., '45.**

Carbon Pile Rheostats **100**

Stackpole Carbon Co., St. Marys, Pa., announces new types and sizes of continuously adjustable carbon rheostats formed of carbon disk piles. By changing pressure applied to these piles, it is stated, every resistance value within their range is made available without opening circuits in which they are connected, such pressure being applied either electrically, mechanically, centrifugally, or hydraulically. Uses of units range from both generator and line voltage regulator applications to speed control through governed field current on motors. Carbon piles are available in virtually any length pile and dia. required.—**AVIATION, Jan., '45.**

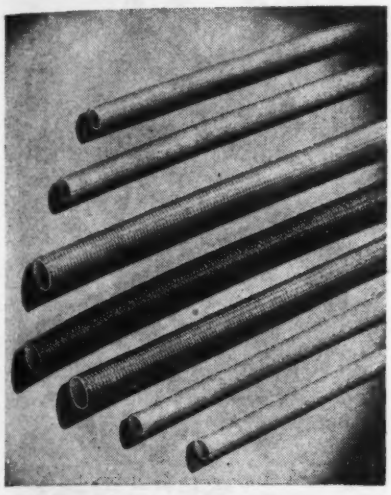
Motor Generators for A.C. **101**

Providing source of 800-cycle constant-frequency a.c. independent of engine driven generators, new Type 800 motor generators designed to operate from aircraft d.c. system, are announced by **Eclipse-Pioneer Div., Bendix Aviation Corp.**, Teterboro, N. J. Operation is fully automatic with closing of remote control switch, and integral carbon pile voltage regulator maintains constant a.c. supply of 115 v. over rated operating range. Ro-

tating field inductor and stationary windings are stated to eliminate use of collector brushes. Weighing 24.5 lb., generator is 11-13/16 in. long, 8-19/32 in. high and 5½ in. wide.—AVIATION, Jan., '45.

Glass Insulation Tubing..... 102

Stated to have great flexibility and to be non-moisture-absorbing and non-burning, "Turbo," new insulation tubing of single saturated glass sleeving, made by William Brand & Co., Chicago, is offered in permanent colors and in any diameter.—AVIATION, Jan., '45.

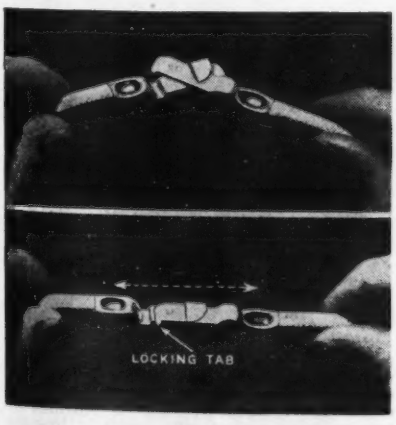


Solderless-Wiring Kit..... 103

Available from Aircraft-Marine Products., Harrisburg, Pa., is new solderless electrical wiring repair kit comprising six-purpose installation tool which cuts and strips wire, indicates stud sizes, and crimps terminals to wire. Included is assortment of 100-amp. solderless terminals.—AVIATION, Jan., '45.

Small-Wires Connector..... 104

Designed especially for small wires, new quick-disconnect type of connector is announced by Burndy Engineering Co., New York City. As illustrated, halves are identical, and when connected in jackknife fashion they lock with slight pull. To disconnect, halves are pushed together and slightly swung. Connection of other end to cable is made by indenting clasp socket to cable strands. Four clasp-connector sizes accommodate 10 sizes of aircraft cable—No. 18 to No. 8. Two smaller sizes include insulation grip on cable sockets.—AVIATION, Jan., '45.



Foot Switch..... 105

Described as flattest foot switch available, Model MF, made by General Control Co., Boston, has foot rest ½ in. above floor and is stated to require only 1/16 in. throw. It is designed to actuate from one to eight circuits.—AVIATION, Jan., '45.

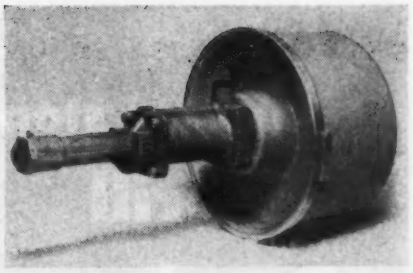
Aircraft Parts & Accessories

Portable Air Supply..... 106

Weighing 24 lb. and permitting filling from regular air source, "Handi-Air", portable air supply holding enough air for eight light plane tires, is announced by Scott Aviation Corp., Lancaster, N. Y. —AVIATION, Jan., '45.

Brake Intensifier..... 107

Described as permitting faster braking action and lower pedal pressures, aircraft model of new "Univac" brake intensifier, made by Pesco Products Co., Div. of Borg-Warner, Cleveland, is suitable for medium size aircraft, with special installations available for aircraft weighing up to 30,000 lb. Unit operates in conjunction with vacuum pump mounted on engine. It is placed in line between master cylinder and wheel brake. Self contained and weighing 5 lb., it is stated to produce desired pressure at pedal force of 50 lb.—AVIATION, Jan., '45.



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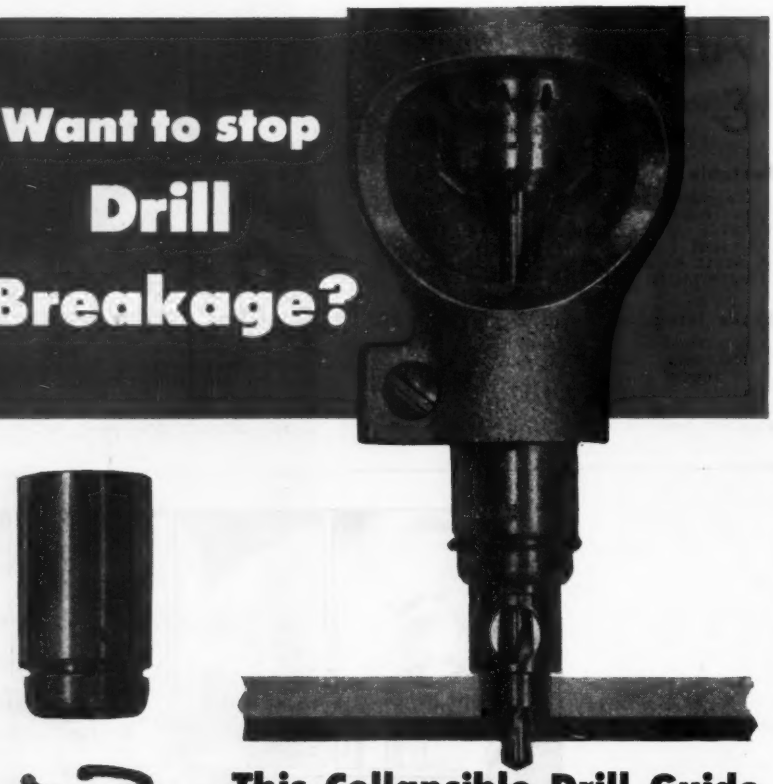

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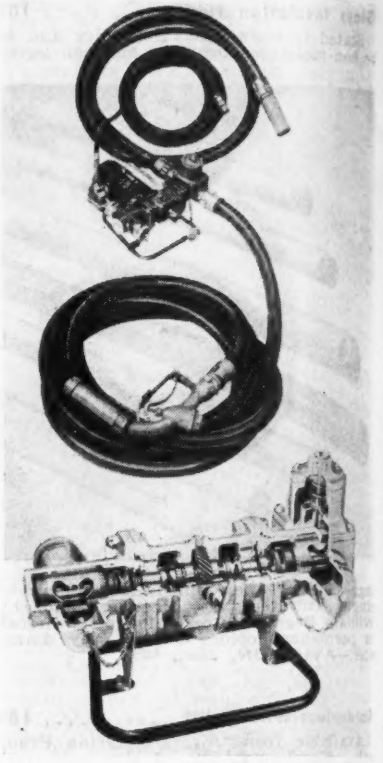
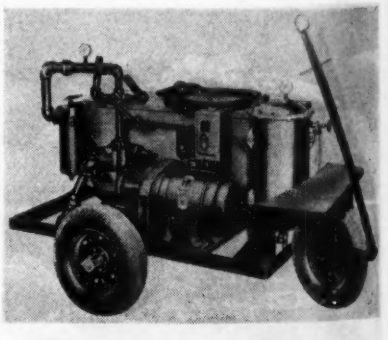


built by **Romec Pump Co.**, Elyria, Ohio, is electrically driven and comprises two rotary pumps, both with off-set motor, sliding blades, rocker seals, and G.E. motor. Drive end of latter is equipped with adapter gearing for both pumps, which are selectively driven. Bilge pump, 1,500 U.S. (1249.50 Imperial) gal. per hour. Weight is 64 lb.—**AVIATION, Jan., '45.**

Aircraft De-Sludger 109

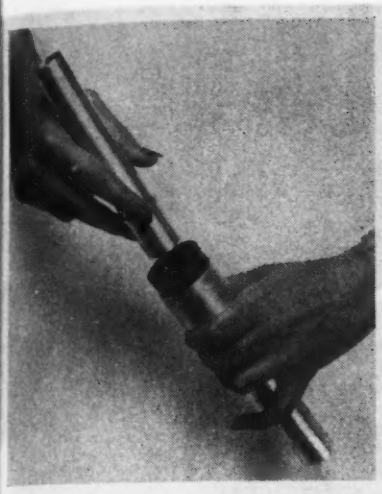
Designed to de-sludge and clean aircraft oil coolers and engines without removal from plane, de-sludger unit No. 2025, made by **Pacific Airmotive Div. of Airplane Mfg. & Sup. Corp.**, Glendale,



Calif., consists of 25-gal. insulated tank with sight level gage. Tank is pre-heated with immersion type heaters with thermostatic control. Pressure is provided by rotary vane pump with built-in by-pass powered by either electric motor or air-cooled gasoline engine. Flow of solvent is frequently reversed by 4-way valve.—**AVIATION, Jan., '45.**

Flexible Coupling 110

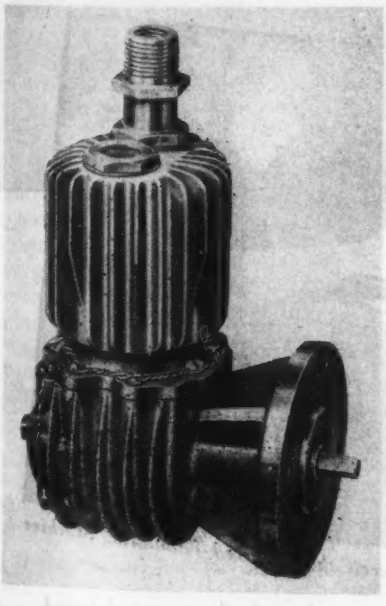
Aeronautical division of **The B. F. Goodrich Co.**, Akron, has adapted "Flexlock" rubber coupling to aviation uses. Coupling is gasket or ring having ribs on fins running circumferentially both inside and outside, inside fins gripping outside surface of smaller pipe, design thus furnishing maximum sealing pressure. Outside fins are designed to grip to bell or sleeve of outer pipe when deformation of



pack takes place, and also to set up strut action through cross section of coupling, driving joint tighter. Couplings can be made of various compounds to withstand heat ranges from —50 deg. F. to +150 deg. F., and to resist oil and aromatics, gases and liquids. Present applications: As high pressure grommet seals, for passing lines for integral fuel tanks, for passing conduits through bulkheads or pressure chambers, as flexible joint for wiring or control cable conduits, and as flexible joint for spigot tubing. Couplings are made for ¾, ⅞, 1, 1.20, 1½, 2, 2½, and 3-in. o.d. pipe or tubing.—**AVIATION, Jan., '45.**

Bantam Air Compressor..... 111

Especially developed for aircraft vacuum use, 2½-lb. air compressor, to be used as auxiliary vacuum source, is made available to manufacturers by **Hartwell Aviation Supply Co.**, Los Angeles. Engine



driven, its design permits conversion to electrical driven unit. Over-all height of unit is 7 in.—**AVIATION, Jan., '45.**

Building Main Streets

(*Continued from page* 111)

subserves they are essentially of the same character. If the ownership and maintenance of one falls within the scope of municipal government, it would seem that the other must necessarily do so. We accordingly hold that the acquisition and control of an airport is a city purpose within the purview of general constitutional law.

I think we can all heartily agree with the full-visioned Justice Cardozo, who said in 1928 that the city of Utica, N. Y., had the right to issue airport bonds, payable for tax funds. His opinion:

We think the purpose to be served is both public and municipal. A city acts for city purposes when it builds a dock or a bridge or a street or a subway. Its purpose is not different when it builds an airport. Aviation is today an established method of transportation. The future, even the near future, will make it still more general. The city that is without the foresight to build the ports for the new traffic may soon be left behind in the race of competition. Chalcedon was called the city of the blind because its founders rejected the nobler site of Byzantium lying at their feet. The need for vision of the future in the governance of cities has not lessened with the years. The dweller within the gates, even more than the stranger from afar, will pay the price of blindness.

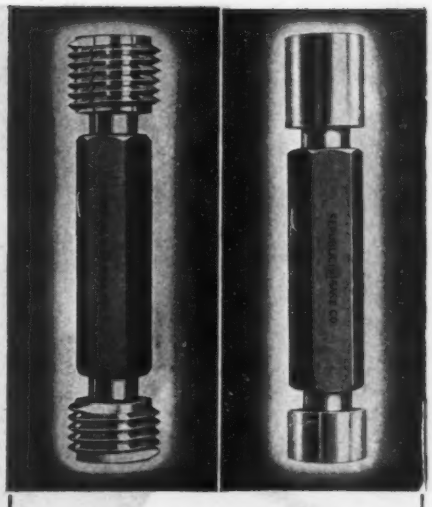
Let's take a look at the municipal airport activity in St. Louis today. Figures indicate that during the month of September there were 1,672 arrivals and departures by scheduled airliners, or an average of about 59 daily.

At the time of Pearl Harbor there were approximately 24,000 privately owned and operated aircraft in the United States. It is my feeling that within ten years after victory we shall have 1,500,000 such planes and that at least 4,000,000 individuals in America will know how to fly.

To accommodate this activity we will need thousands of smaller fields. Our returning airmen and members of the armed forces will want, in their home communities, the airports from which they can fly and operate services for others. The CAA airport plan for postwar flying is indicated by the following comment:

As a by-product of the war, we have the necessary manufacturing facilities, and a huge pool of potential pilots. At the end of the war there will be approximately 350,000 Army and Navy pilots and 150,000 civilian pilots and students. Also interested in flying will be 2,500,000 men trained by the Armed Forces in other aviation skills, and an almost equal number employed in our aviation factories. Add to these the 250,000 students who are taking aeronautics courses in the high schools each year, and there is a total of 6,000,000 prospective flyers.

There is no way to estimate accurately the number of these who actually will take up flying as a vocation or avocation, but if only one out of four did so in the immediate postwar years, there would be 1,500,000 airport users, plus millions of prospective airline travelers. In addition there are many persons outside of these specialized groups who even today are evidencing interest in flying, for business and pleasure.



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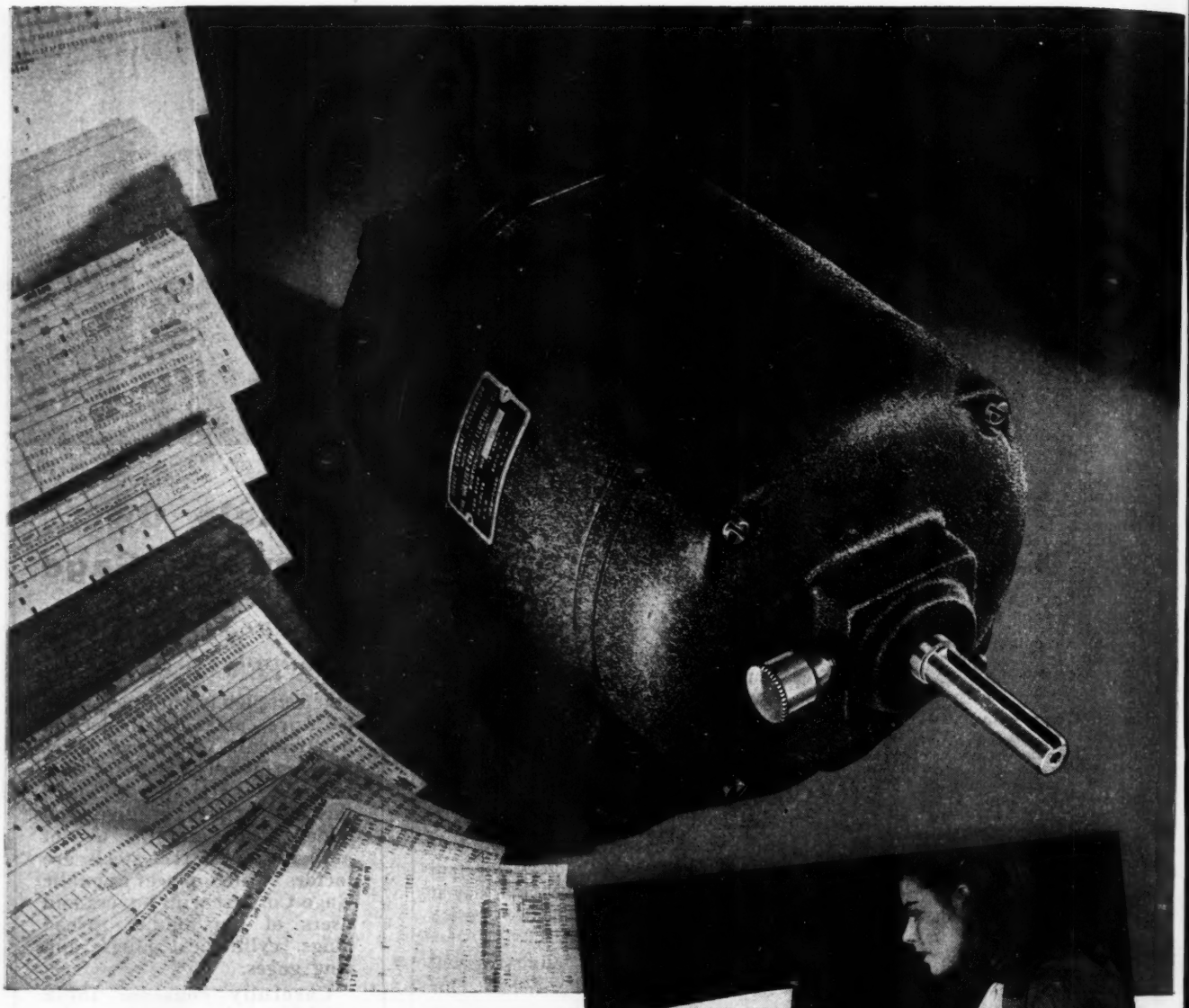

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The problem of a well-known manufacturer of business machines was to obtain a motor and a generator that not only provided the correct power to operate extremely sensitive solenoids but also fit the space which was at a premium. Holtzer-Cabot motor development engineers tackled the job and designed a special motor and generator with the proper performance characteristics in special frames which fitted the space specifications . . . and another motor problem was solved.

For over 50 years Holtzer-Cabot has concentrated its energies in designing and building special motors.

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—Americans are increasingly conscious of the need for developing aviation. The lifeblood of a nation it its trade. To exist at all it must produce and sell its material or its people die. To become great it must create markets for its production both within and without its borders. In the midst of war there has been held, at Chicago, the International Civil Aviation Conference, with practically all of the countries of the world sending representatives to fashion a plan under which air transportation may operate effectively and peacefully among peoples everywhere.

Congress is fully determined that when we spend a dollar in the postwar period it will be a tax-dividend dollar. In other words, we should appropriate the money of the federal government with great discrimination, knowing this dollar will give a dollar's return. Airports throughout America will be a real investment which will bring our people closer together in the bonds of business and well-being.

One lesson this terrible war has taught us—a lesson that our airmen have been trying to pound into our heads for a long time—is that future world trade is inexorably bound up with the development of flying. The nation with the best and the most planes, the best and the most highly trained pilots the best and most ingenious designers, laboratory technicians, and productive capacity will, at that time, be in a favored position.

But many other factors will enter into the problem. There must, above all else, be the national ability for long-range vision in a field that is so vital to world stability.

Airport building, which should be done by the contract system for best results, becomes a symbol of the world on wings and wheels. An airport is the *Main Street of Aviation.* Without it there can be little practical flying.

The community that possesses an airport becomes the focus of radiating lines of communication with other cities, other states, and other countries. Through its use there is extended the circumference of living, for its citizens, to the far reaches of the earth.

The same might be said of other means of transportation—but for the time element. It is notable that aviation has shrunk the globe to miniature dimensions. It has ended all normal conceptions of isolation. The great gift of flight, with its many uses, can remake a world and provide definite means for a lasting peace.

Heat Treatment Speeded

(*Continued from page* 146)

by a slowdown switch (located 1 ft. from final position) which opens the high-speed contactors and connects slow-speed motor winding to check the load before the automatic stop, when

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Randolph "4" Carbon Dioxide Fire Extinguisher

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truck is precisely located. Automatic stop switch also causes the furnace and quench doors to close.

After quenching, operator pushes *Quench to Unload* button, which raises quench doors to their upper limit, after which the conveyor motor is energized and load pulled to unloading position, where it is stopped by a limit switch.

Load may be taken directly from furnace to unloading position by pushing a button marked *Furnace to Unload*, whereupon door opens fully and conveyor pulls load through quench chamber to unloading position. When load stops, furnace door closes.

Fifth push-button, for emergency purposes, is much larger than the others and is painted red. Also on the control panel are push-buttons for independently operating the conveyor, furnace door, quench door, and quench valves. These push-buttons are not operative unless selector switch is turned to *Manual*.

Contactors and relays for power and interlocking sequences are in the control cabinet, power for which comes through a fusible switch from the power bus. A general single-line wiring diagram is shown in Fig. 4. Contactors and overload protection for the motors are also included in this panel, with limit switches, solenoid valves, water level switches, etc., for complete automatic operation.

Main power for heating is brought through three three-pole, fusible switches on power panel, and from there through three controlling or throttling reactors to the furnace.

Effect of reactors in the circuit is varied by Reactrol power panels, governed by the temperature controller. Each independent temperature controller is actuated by a chromel-alumel thermocouple in the top of the furnace, near the fans. A limit control in each zone shuts off power if temperature passes a pre-set value. Fig. 5 is a schematic diagram, showing relation between reactor and its control.

Because of the high rate of heat transfer it was desirable to use a continuous power control. Highest transfer rate is early in the cycle, when the temperature gradient is high. Thus, it is advisable to control the input continuously to prevent overshoot, as temperature reaches the control point.

This continuous throttling also eliminates overshoot during the soaking period. Though usual heat-treating temperature for aluminum alloys is 920 deg. F., the work may be damaged at 937 deg. This narrow margin of safety is easily maintained by a throttling control, but the on-off type may overshoot.

The throttling control is also much easier on the power system than the

on-off type. Since there is no actual interruption of the circuit, no switching transients or bumps occur, to cause trouble elsewhere with sudden voltage changes.

The reactor-electronic tube control operates from a potentiometer balance identical with that for on-off control but with an extra potentiometer slide wire, the contact of which moves as the instrument effects temperature changes. Low voltage current is supplied to this potentiometer from the Reactrol panel and is fed into the amplifying tube at the voltage between the movable contact and one end of the potentiometer. This amplifying tube feeds a grid-controlled rectifier which consequently furnishes d.c. at a voltage governed by the position of the potentiometer fitted in the temperature controller.

The Reactrol panel supplies this direct-current to saturating winding of reactor, increasing current when the temperature instrument calls for increased power output to the furnace, and decreasing current when less power is needed.

The saturable-core reactor, regulating the amount of electric power flowing to the furnace, consists of a laminated iron core carrying three windings. The two a.c. windings are connected in series with the furnace across the main power supply, while the d.c. winding is connected to the Reactrol panel. With no current of the d.c. windings, impedance of the a.c. winding is high and most of the power-supply voltage is absorbed across the reactor, hence power input to furnace is at a minimum. Reverse is true when maximum current flows in d.c. winding.

Intermediate values of power input are obtained by varying d.c. current. Reactor installation for this furnace can vary power input between 100 percent (600 kw.) and 1 percent (6 kw.) in an infinite number of steps.

Fig. 6 is a geometrical representation of voltage relations in reactor-furnace circuit. In this diagram, it is assumed that reactor voltage leads line current by 90 electrical deg., as would be the case if a perfect inductance were used. Heating unit voltage (assuming that the heater is a pure resistance) is in phase with the current.

Arrow *OB* represents line voltage, which remains constant. Lengths *OA* and *AB* are the proportionate voltages across heating units and saturable reactor, respectively. As the reactor is saturated magnetically by d.c. from the Reactrol panel, voltage *AB* decreases and voltage *OA* increases. Necessary value of *OA* for a given heating requirement is automatically maintained by the Reactrol panel.

Conveyors handle a wide variety of commodities—parts, packages, units, cartons, cans, bottles, barrels, bundles, drums, boxes. Available in light, average, or heavy-duty types for portable or stationary use, in a wide variety of sizes, styles, and lengths . . . all built by Standard. They give you substantial savings in time and money. Engineers say that material handling constitutes about 22% of manpower cost . . . cut handling costs and you cut production costs.

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Air Power

(*Continued from page* 114)

All nations must review their strategy in the light of these established facts. The United States, as a part of the western hemisphere, is a continental power with respect to that hemisphere. Fortunately she has no rivals and thus many good neighbors. But had she rivals or enemies she might well rest her military security with respect to the continent in her Army Air Force. This would call for further development of the idea of an airborne army capable of swift movement of a completely integrated ground force. Other nations will assess this idea in the light of their own situations.

However, the United States, with respect to the rest of the world, is an insular power. We have fought overseas campaigns on two fronts, the European and Asiatic. In the European campaign the British-American command of the sea enabled us to concentrate the Army Air Force within range of our objectives.

In the Asiatic theater the same process was followed, but one phase of the Pacific war deserves most careful consideration. Gen. MacArthur, starting from Port Moresby, dominated New Guinea by leap-frog tactics along the coast. The future role of the Army Air Force must be studied from this concept. At the beginning of the war, airborne attack was conceived as requiring specially trained troops and special light equipment. Today, there is a tendency to treat all ground forces as potentially air transportable.

This involves, among other things, a re-study of ground force equipment to lighten it and make it more compact and efficient for air transport. It leads also to a replacement of the commercial air transport planes, borrowed from the airlines, by craft designed especially for this purpose.

Air Power has introduced completely new strategic factors of fundamental importance. The Army, under Gens. Marshall and Arnold, has been quick to appreciate this fact. Air policy seems destined to control the future course of history.

Anti-Friction Bearings

(*Continued from page* 164)

whether there is any "catch" in its action. If there is a tendency to roughness or sticking at any point, reclean the bearing and check again. If still rough, inspect it in greater detail, as follows:

Check surface of balls for evidence of wear or flaking (bearings in magnetos sometimes become pitted from electrolysis). Look for broken or cracked rings, separators, balls, or rollers. Dented shields or seals often cause sticking and should be replaced. If none of these are present and bearing still is not smooth in action, observe working surfaces for discoloration through overheating, also examine raceways for impressions made by balls or rollers either when overloaded or if bearing was struck.

Anyone of the above signs is reason for rejection. Spalled, chipped, or flaked bearings should *never* be returned to service.

Bearing replacement is the reverse of removal, and here the same precautions should be observed. Pullers may be used in many instances to put bearings onto a shaft as well as to remove them.

Always clean shafts and housings thoroughly, removing chips and dirt from keyways, splines and grooves, and oil-bearing seats.

Press bearings on straight and square, applying pressure only to ring, which takes tight fit. Do not remove pressure until bearing is tight against shoulder or housing. If an arbor press is available it should be used, supporting inner ring on blocks (Fig. 8), though a tube protected by a wood block will be satisfactory, provided the ends of the tube have been accurately squared.

When the shaft is to be flushed with the bearing, use a flat-end drift in the arbor press, which will not force the bearing beyond the end of the shaft.

Inner rings of large bearings are often heated in oil to about 200-250 deg. F., which expands them sufficiently to permit slipping over the shaft. If slight additional clearance is required, shaft may be shrunk in dry ice before applying the hot bearing ring.

Thrust bearings are cleaned, removed, and inspected as are other types, except that the roughness test is made by laying them flat on a table and applying both pressure and turning movement with the palm of the hand.

Open-ball type thrust bearings may be a slip fit or one or both races may be tight. Where pressed in place, individual races are fitted separately, pressure *never* being applied through the balls (Fig. 9).

Banded thrust bearings, being inseparable, are pressed in place while being slowly rotated. Method of doing this with a drill press is shown (Fig. 10).

To accomplish a satisfactory assembly, the following practice is recommended: (a) Do not wash *new* bearing in solvent, instead wipe off rust preventive on outside with clean rayon cloth; (b) squirt a few drops of oil on bearing seat on shaft; (c) start

COLONEL JOHN CASEY, *Manager, Chicago Municipal Airport . . .*

Colonel Casey said, "The growing complexities of airport traffic make it ever more important that private planes and regular operating passenger aircraft be equipped with up-to-date, reliable two-way radio, if high standards of safety are to be maintained. One important factor is . . ."

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Colonel Casey, Electronic Laboratories has long been aware of the need for reliable power supplies especially adapted for aircraft use. One of E-L's exclusive developments along this line involves vibrators operating in parallel which assures a reserve power source for extra protection. These Vibrator Power Supplies—both light and heavy duty—are specially designed for complete reliability at very high altitudes.

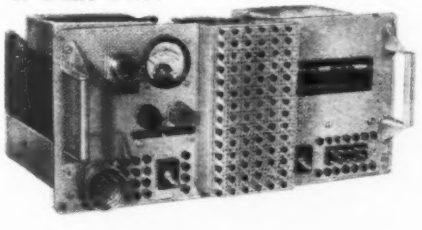
The life of E-L Vibrator Power Supplies is far beyond the customary overhaul requirement. With these units maintenance time is cut to a minimum—only a small fraction of the time previously required.

Other E-L developments for the aircraft field include units for flashing wing lights and for instrument panel illumination. This equipment has wide application for the light plane field as well as for large aircraft.

The economy and versatility of Vibrator Power Supplies are also available to the marine field—where units have been designed to provide fluorescent lighting, radio-telephone operation and electrical appliance use—as well as many other fields where it is necessary to convert current to specific voltage and type requirements . . . Let E-L engineers consult with you on your power supply problem.

STANDARD POWER SUPPLY MODEL SC-1096

Model SC-1096 is a typical E-L Vibrator Power Supply which meets the requirements of aircraft radio use. This unit was designed for the Canadian Signal Corps to operate radio transmitters. Input voltage: 12 volts DC, or 110-117 volts AC at 50-60 cycles. Output voltage: 2000 volts at 125 ma., 400 volts at 25 ma., 250 volts at 10 ma., 250 volts at 5 ma., 10 volts at 5 amps., 12 volts at 1 amp. Output power: 480 watts. Dimensions: 17" x 12⅜" x 7¾".



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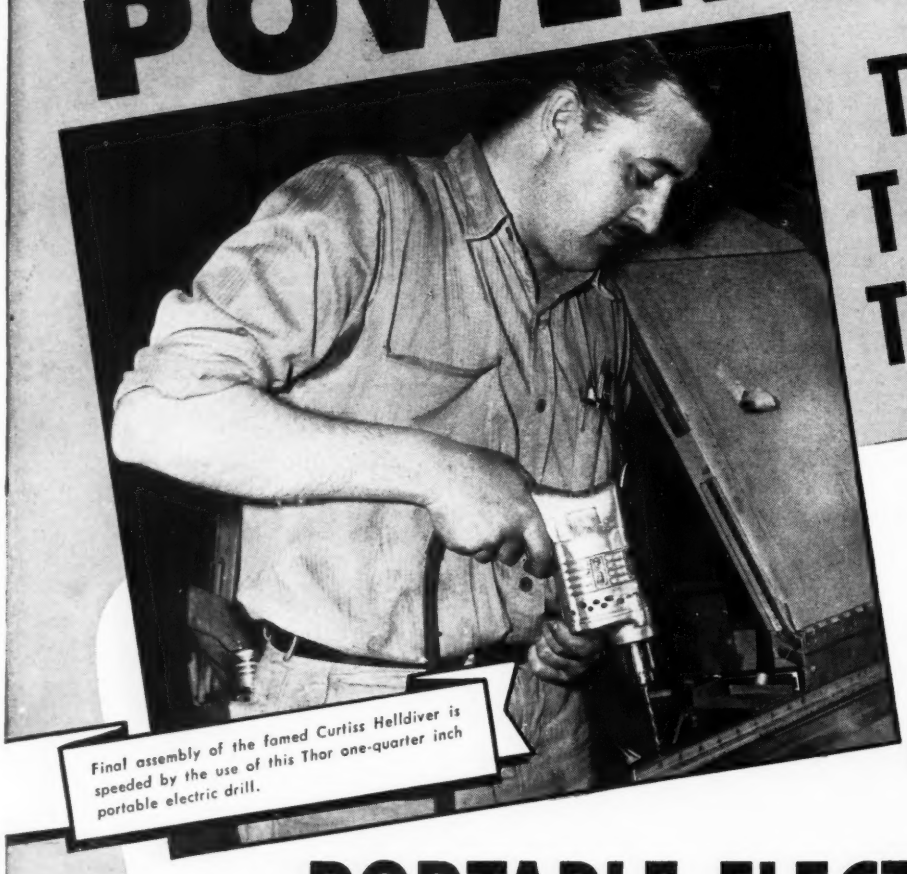

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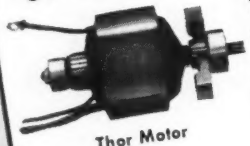

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Thor combines balanced motor design with lightweight construction to provide this greater power and faster, easier handling.

The Thor motor, producing true, smooth-running power because it is balanced both statically and dynamically as a complete assembly, is ruggedly built to stand up . . . *longer*, under the toughest operations.

Thor housings of strongly reinforced aluminum alloys and, in late drill models, of durable "Thorite" plastic, are compactly built to reduce weight to an absolute minimum without sacrifice of motor size and capacity, providing the light weight and handling ease that adds *speed* to power to get jobs done faster.

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INDEPENDENT PNEUMATIC TOOL COMPANY

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bearing by hand, making sure of square start; (d) place on clean drill press table (Fig. 10), and (e) running at lowest available speed, press down with chuck inside bearing, until completely seated (if chuck is too small, use small shank pilot).

If a shaft has been scored and then polished, so that the bearing is looser than it formerly was, do not knurl or prick-punch the surface to make it retain the bearing. Install "as is" until the shaft can be plated or metallized oversize and then brought down to correct diameter.

Lubrication is as important in antifriction bearings as in any other type. Use the lubrication chart supplied by the maker of the machine or unit, applying grease only where grease is specified and oil where the chart calls for oil. By using exactly the kind of lubricant specified by the manufacturer, and in the quantity called for, bearing life will usually be prolonged considerably.

If bearings are left standing for long periods, they should be turned occasionally to prevent the accumulation of moisture in the exposed parts of the bearing and also to spread the lubricant, which tends to run down to the lower side of the ring.

Foreign Trade Is Key

(*Continued from page* 118)

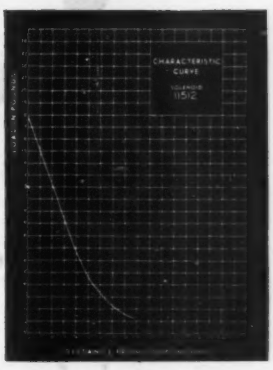
len exchange and gold balances. The nationals themselves would like consumer goods, but they will live under regimented economies and their governments will say no.

Their government officials know full well that if they let down the bars and permit extensive imports of household appliances and other consumer goods, the balances here would be greatly depleted long before their industrialization programs were completed. So the consumer goods will have to wait. At least that's the story government officials and businessmen alike visiting here from all over the world have been telling us in Washington, Chicago, Bretton Woods, Dumbarton Oaks, and Rye, N. Y.

Then there's another angle to the postwar foreign trade picture that aircraft manufacturers must weigh seriously. This fourth Roosevelt Administration is going all-out for foreign trade to supply 3,000,000 to 4,000,000 of those 60,000,000 postwar jobs to which it is committed. So the first big program to bring about full employment will be stimulation of foreign trade.

Note how the speeches and writings of such influential New Dealers as Harry Hopkins, Henry Wallace,

Faster, more efficient operation with CANNON D.C. SOLENOIDS



Response characteristic charts like the above (test at 28 volts) together with wiring diagrams are found in Solenoid Bulletin.

With Cannon Electric D.C. Solenoids you get automatic, trigger-action. Solenoid pull is positive. Cannon Solenoids may be operated without damage to a maximum temperature of approximately 150 degrees C.

A wide selection of Cannon Solenoids are built for various combinations of voltages, pull, armature travel, duty cycle, etc. to suit design requirements. Nominal voltages are 12 and 24; others by special order. Eight types have "holding" features.

As a reliable means of controlling or operating various devices, they are used for retarding magnetos in starting engines, operating hydraulic valves and mechanical clutches, firing machine guns, arming and releasing bombs, dropping auxiliary fuel tanks, locking retracting gears, film-winding mechanisms for shutter control on special cameras. These are only a few of the possible applicaions. *Let us know your needs.*

A copy of the Cannon Electric Solenoid Bulletin —34 pages of diagrams, data and photos of the complete line will be sent free for the asking. Address Department A-110, Cannon Electric Development Company, 3209 Humboldt Street, Los Angeles 31, California.

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Lauchlin Currie, and others, center on the theme of building foreign trade to provide jobs. And in the old-line departments of State and Commerce, Dean Acheson, Charles P. Taft, Wayne Taylor, and William A. M. Burden are busily planning the future foreign trade program.

Mr. Currie, for example, blithely talks of postwar exports of $14,000,000,000 annually against $2,800,000,000 a year currently, exclusive of lend-lease. Remember that during the decade from 1929 to 1939 our exports ranged from $2,100,000,000 to $4,000,000,000 annually.

But that doesn't mean that our government won't be successful in doubling or tripling peacetime exports if that's what it wants to do. After the last war, private investors got badly burnt by lending money to other nations so they could buy here. After this war it will be the American taxpayers, through their government, who will make the loans when foreign balances begin to run low, as they eventually will. And, if past performance is any criterion, it will all be done in a grand manner.

Just as government war orders skyrocketed aircraft into the nation's leading wartime industry, so will government stimulation of foreign trade present the same industry with the golden opportunity to rank with the automotive, steel, and other great exporting industries in overseas markets.

Now let's consider briefly some of these new markets, starting with India. Before the war, India was almost hopelessly in debt to Great Britain. India will enter the postwar era a rich creditor nation with its foreign debt liquidated and a huge accumulation of sterling balances to her credit.

India already has its 15-yr. $30,000,000,000 Bombay Plan to stimulate industrial and agricultural development. In the first 5-yr. period after the war, $1,500,000,000 will be allocated to basic industries and $900,000,000 for consumer goods industries. There are to be eleven regular air services spanning the length and breadth of that country. New air routes covering 10,500 mi. are stipulated, with an annual flying mileage of 7,500,000 mi.

The Bombay Plan says: "a substantial part of this capital will have to be spent in foreign countries for importing necessary equipment which will not be available in India."

Indian opinion strongly favored development of airplane engine manufacture there. The British think differently on this question. Sir Frederick Tymms gave Britain's answer when he recently said, "To those who cry for the immediate establishment of a full-fledged aircraft manufacturing industry, I say that industrially there are

many more profitable things to do in supplying India with common things—pins for example.

"A new industry (of aircraft in India) could not hope to compete in the export market with the aircraft industries of Great Britain and the United States. We have two aircraft factories in India which will provide the means of establishing a peacetime industry. The approach will be through overhaul and servicing of planes, working progressively up to production of a small indigenous trainer."

Now let's move on up to China which, with all her financial difficulties, has a 10-yr. plan of industrial and agricultural reconstruction and expansion. Here, too, the emphasis is on transportation and communications in the early stages of the plan. Generalissimo Chiang Kai-Shek has written a book, called *China's Destiny*, which goes into detail on the plan. According to this important volume, which has never been translated into English, 120,000 commercial transport planes will be needed as part of the transport program.

There are those who believe that trade prospects in Asia are greater than they will be in war-torn Europe for many years. However that may be, the aircraft industry can plan on an immediate postwar market of large proportions if it goes after it. Turkish trade missions recently set out for the United States with $135,000,000 figuratively jingling in their pockets with which to buy American goods.

Portugal, with its overseas empire, has ambitious plans for becoming a great air transport nation. Netherlands authorities put transport equipment just under pumps as their most essential import needs. The French want American aircraft, while Norway, Sweden, Denmark, and Belgium have large credits, secured through the earnings of their foreign possessions or their maritime fleets, to use in foreign purchases. European postwar aeronautical trade here may be mainly transports, but some hold that there are possibilities, during the reconstruction years, at least, in the personal plane field.

Russia is expected to be the heaviest single bidder for American equipment, with her needs ranging upward from $10,000,000,000. How much of this includes aeronautical products is a moot question. The Soviets aren't saying. But the general presumption is that they are interested mainly in acquiring rights to manufacture American aircraft in their own plants.

Swinging nearer home, there is Latin America to consider. The nations south of the Rio Grande have more than $3,000,000,000 in gold or

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credits here, as compared with $592,000,000 in 1939. Argentina stands first, with gold and foreign exchange reserves (partly held in London) of more than $1,200,000,000. Of course, diplomatic relations between Argentina and the United States today aren't exactly friendly and Britain holds a competitive edge on that market. But it's well to remember that Argentina bids fair to keep on being the most prosperous Latin American nation after the war and that her diplomatic relations with us are likely to improve over the long range.

Brazil holds the second largest trade balances, an amount now approaching $800,000,000 as against only $67,000,000 in 1939. Mexico stands third, with $300,000,000 in balances built up during her one-way trade in wartime. Even today, Mexico City is the hub of a system of 31 competing airlines, 8 of which are American controlled. The country has about 35,000 route miles as against 55,000 here, though our population is more than six times greater than that of Mexico.

A fair pattern of probable postwar trade to Latin America is set forth in a letter recently received by a leading New York bank from a Venezuelan banker—a letter which seems typical of the postwar thinking in every South American nation. He writes that the first and foremost need of Venezuela is transportation: Airplanes, trucks, automobiles, buses, "and possibly railway rolling stock." Then will come the demand for farm machinery, construction of roads and highways, and power machinery. Finally, when industrialization is well under way, there will be a large demand for household equipment, electrical goods, textiles, chemicals, etc.

This letter shows how high the priority for aeronautical products stands in Latin American markets that are expected to import $10,000,000,000 worth of new and used equipment in the first ten years after the war.

Here, then, are the markets which may well mean the difference between profit and loss for a large segment of America's—and the world's—No. 1 industry. They are markets which will help maintain solvency for those executives who plan now to get their share.

EDITOR'S NOTE: *In subsequent articles, Mr. Hoadley will discuss other phases of this important foreign trade question. Next month he will cover the probable sources of competition, describing how tough they may be expected to be; then he will give practical, working suggestions to help the industry establish itself in this great primary aircraft market.*

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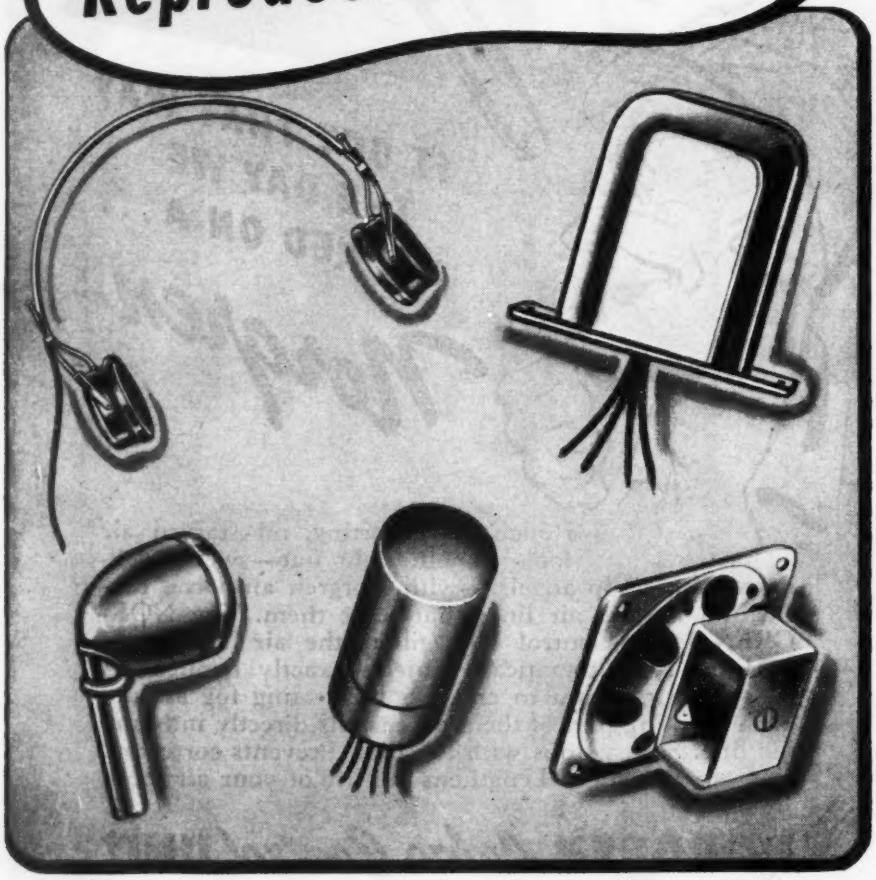

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Plastic Distortions

(*Continued from page* 148)

Over-all displacement of the image—provided it is not extreme—is of negligible consequence when, for example, a fighter pilot looks over his shoulder and sees another airplane approaching. What he does here is appraise the situation, rather than make a precise observation, such as preparatory to gun fire. Hence it matters little if the actual location of this other airplane is a trifle to one side or the other of where it appears to be. He is operating in relation to no closely fixed reference point.

If his view of the airplane image itself is in any way impaired or distorted, instantaneous recognition of the craft's type and affiliation will be considerably more difficult. Any areas of distortion present in such an enclosure, once they have come to the attention of a pilot or gunner, may become a decided psychological hazard. The nuisance will far outweigh the inclosure's practical advantages. Such distortion therefore is doubly to be avoided.

Determination of optical inspection procedure for scanning panels which will operate in terms of definite standards and measurable values is far less straightforward than in the case of sighting panels. Purely visual methods —i.e., looking through the enclosure at a grid and observing waviness of the lines, etc.—while theoretically more sound in these applications than where a line of sight is involved, are subject, as noted before, to considerable variation in results with different inspectors, at different times, or under slight variations in setup. Where distortion is normally very slight anyway, it is almost impossible to obtain consistent judgments by this means.

A somewhat better method, though still subject to individual opinion, is the use of a point source of light. Special bulbs are available, having an incandescent ball of small diameter instead of a filament. When these cannot be obtained, other means may be used to produce a light source of small size, probably the simplest being to shield a standard bulb with a light-proof cover which has only one small hole.

This point source of light is set up in a darkened room, and the enclosure to be inspected is introduced between the light and a screen or white wall. The part is moved about, preferably in such a way that the position of the light approximates that of the observer's head when the enclosure is in use. The lensing effect of any surface irregularities then tends to disperse or concentrate the light rays emanating

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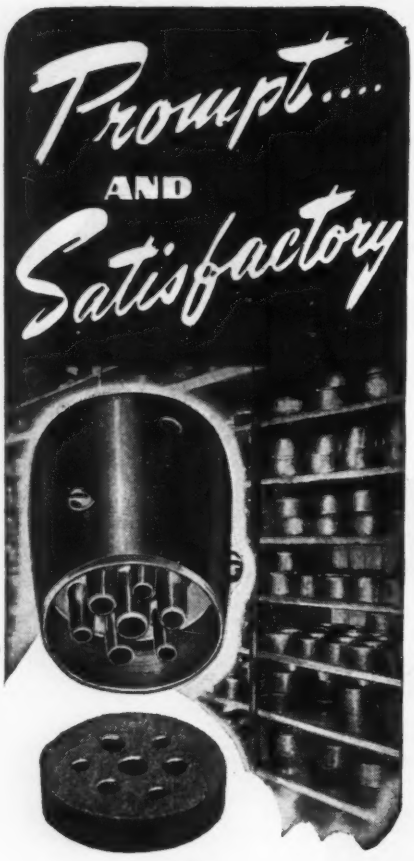

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from the point of illumination, resulting in a readily observable pattern of light and dark areas on the screen.

The clarity and extent of these patterns is a measure of the degree of localized optical distortion in the part. They are far more readily perceived and evaluated than the waviness of lines on a grid, but they cannot be objectively analyzed or measured.

Determination of quantitative values for local abberrations requires the use of a projected image, using a setup basically similar to that discussed above for sighting panels. Since in this case an area is to be examined—rather than a point on the surface—the target must bear a pattern, and a similar pattern must be projected upon it, so coordinated that when nothing intervenes the projected pattern will register exactly with the target pattern.

The most readily handled arrangement consists of a card on which is drawn a number of circles of the same size; the projector contains a slide which will throw a dot in the center of each circle. When the enclosure is introduced into this optical system between the projector and card, the dots will be displaced from the centers of the circles by the distortion of the plastic sheet. If the card can then be moved so that the dots will all fall within their corresponding circles, that area may be considered acceptable. The size of the circles, of course, depends on the allowable limits of distortion which have been determined for this application and upon the distance between the enclosure and the target.

Two or more concentric circles may be used at each location on the card, the smaller circles representing limits of variation for the more critical areas of the enclosure, while the larger ones are used to inspect less important sections. It will be noted that by moving the target card for each area under examination, reference to any datum point is eliminated; this method determines only the variation in angle of refraction within the area being inspected, i.e., localized abberration.

While it is theoretically more exact than the mere visual judgments, this procedure has numerous practical drawbacks. It is obviously tedious, since it requires that the card be moved during inspection of each portion of the surface of the enclosure; in order to provide strictly valid results, each area examined should overlap the preceding, adding to the checking burden.

Further problems arise in relation to the projector, which must have a relatively small objective lens and be placed a considerable distance back of the enclosure to be checked, in order that the rays of light which will make the final image will already have resolved themselves into approximately the proper relationship when they pass through the part.

In other words, each cone of light whose base is the objective lens and whose apex is the dot on the target must already be well separated from its neighbor when it arrives at the plastic sheet, otherwise the results will not afford a true picture of the distortion present. For easy observation, the target must, at the same time, be at some distance from the part being checked in order to provide adequate exaggeration of the deflection of the light rays.

These factors not only introduce problems of floor space but will require an unusually fine projector to throw a clear image of small dots for such a distance. The difficulty will not be mitigated appreciably by using a different pattern, such as overlapping grid lines, for the latter must be very nearly as clear. In the light of these objections, it is doubtful whether the projective method is worth using in any but the most critical applications.

It is not to be considered that the two types of optical checking discussed here are all-inclusive. Many other specialized applications also exist, each presenting unique problems. Combinations of sighting and scanning panels are also common, as when a gunsight operates only through a small portion of an enclosure and the remainder is used for pickup. However, the methods outlined above, or adaptations of them, are adequate for the majority of cases.

It is beyond the scope of this article to consider the actual limits of deflection and variation in deflection which are to be established in any given case. These will presumably be different for each new application. They will generally be a compromise between the ideally desired condition and a tolerance which will permit of reasonably economical manufacture.

It is seldon worthwhile or necessary to establish limits which will result in consistently high rates of rejection. If this is found to be the case, it is usually possible to slightly redesign the part to permit easier forming methods and hence improved optical properties.

Research is Indispensable

(*Continued from page* 117)

cific facts can break up such arguments.

Applied research and development in aircraft laboratories is very new; most companies even now are re-organizing their laboratory personnel for a better postwar position. It is therefore possibly in order for the aircraft test engi-

neer, mathematician, and technician to survey some of the older laboratories of industry and listen to the advise of their leading scientists.

The purpose of industrial research, according to Dr. E. R. Weidlein,[1-8] is "to develop, without preconception or prejudice, a knowledge of the facts, the laws, and the processes of technology. Interwoven with these tasks is the development of systematic procedure, ideals, and aspirations". Ross,[1-10] further states that "research should be an integral, self-sustaining part of an industry and not a department surrounded by brass rails to be shown on the books as an advertising luxury".

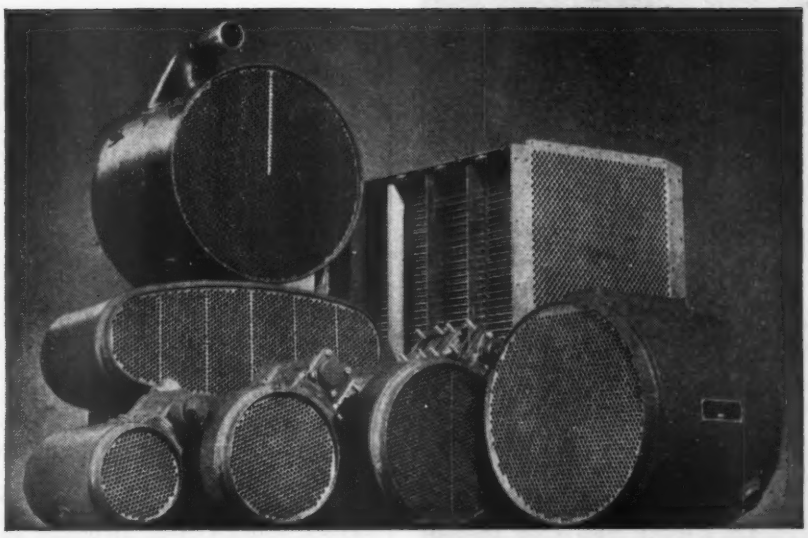
He further adds that "all research should reflect itself on the products which the company makes and sells and should do one or more of the following things: (1) Reduce cost of production, (2) reduce operating costs to the user, (3) increase the utility of the product, (4) increase its sales appeal, (5) produce new business, and (6) determine technical information contributory to some other project."

Research and Development Are "Musts"

Industrial research is a matter of extreme social and national importance. Even the most hard-headed business and banking executives are beginning to see this. Forty years ago industrial America was practically innocent of research workers and research technology. Yet today, according to Maurice Holland, director of the Division of Engineering & Industrial Research of the National Research Council, "there is no industrialist of importance who has not either accepted research with enthusiasm or else reluctantly admitted that his science-minded competitors are laying profane hands on the methods of his grandfather."

So widespread, in fact, is the conception of research as a vitalizing force in industry that executives and bankers no longer ask themselves why they should encourage research. They want to know how to do it. They know that research and development are insurance against the scientific surprise of rivals, and they want to take out such an insurance policy.

F. R. Bichowsky, in his excellent book *Industrial Research* gives a very practical example of the destructive power of the absence of research, quite contrary to the demolitions of the present war made possible by science misapplied. In 1850 there were over 2,500 mi. of canals completed or under construction in the United States, into which over $150,000,000 had already been invested, equivalent to an expenditure today of approximately $7,000,000,000. To quote:



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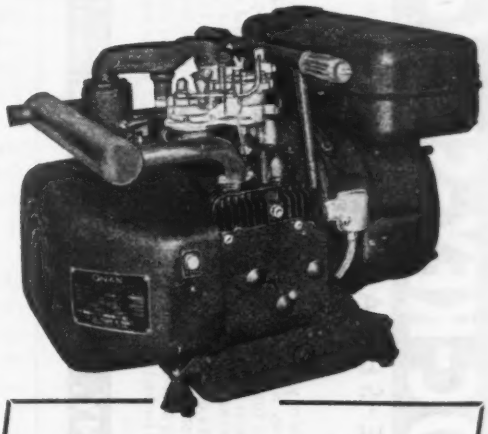

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"Of course there was being tried out another newfangled, dangerous, expensive, uncomfortable, noisy, smelly, dirty method of transportation by some fools down Baltimore way, but anyone (in 1850) could see that the steam railroad was just a fad and never could compete with the canal."

Yet in spite of these arguments, in 1860 the canal was dying and by 1870 it was most certainly dead, having indirectly contributed to the default of the canal bonds and thus to the panic of 1856. This technological loss is directly chargeable to the research mindedness of the early railroads or, more fairly, to the canal management which failed to insure against the loss.

There is, concludes Bichowsky,[I-4] no menace which can be as deadly to an established business as industrial research. No war, no panic, no bank failure, no strike, or fire can so completely and irrevocably destroy a business as a new and better product in the hands of a competitor.

What is Research?

Boyd[I-1] mentions the difficulty that is experienced by the wife of a well-known research engineer in being able to tell her folks just what it is that her husband does. Maybe one of the reasons is that she does not understand "research" very well herself. Even among those actually engaged in research there are differences of opinion about what "research" is and what the limits of its definition should be. People know, of course, what teachers, lawyers, doctors, farmers, butchers, politicians, and even racketeers do, but they cannot imagine how a research worker or laboratory technician puts in his time.

Redman[I-8] states that the "systemized effort to gain new knowledge we call *research*" and that "experiment conducted for the discovery of new facts and their relation to other facts is *scientific research*". He concludes: "When plant experimenting was put on a business basis, it became known as industrial research. Two types of industrial research exist in (1) what may be called *Research* proper, which employs the small-scale laboratory equipment of academic research and differs from it mainly in objective, and (2) *Development*, or the experimental application of research to industry, which is another name for invention".

Boyd[I-1] states that "research laboratories may be divided into two types: The divergent and the convergent. Under what is thought of as the *divergent* system, the various men working on a project are entirely dominated by the head or the leader. Everything there radiates out from him. He it is who furnishes nearly all the ideas and who even decides upon the specific means by which they shall be tested or put into effect. This is in substance the principle of the old-time individual inventor, but pursued now in an organized way or under conditions which provide him with plenty of help to carry out his directions.

In what is thought of as the *convergent* system, on the other hand, that staff is made up of a group of men of large individual capabilities or attainments of their own, all of whom pool their ideas and efforts towards some specific end.

The two systems of research just named are paralleled precisely in business. "There are two kinds of big men in business", to quote one writer. "First there is the business builder" who "rarely surrounds himself with able associates. . . He wants men around him who do what he tells them to do—pronto. . . His ideal of a perfect prime minister is an echo (divergent type). . . The other kind of big man in business builds and leads an organization of men—the men build the business". (Convergent type.)

The National Research Council in compiling the seventh edition (1940) of *Industrial Research Laboratories of the U. S.* adopted a liberal interpretation of the term research: "Industrial research is the endeavor to learn how to apply scientific facts to the service of mankind. Many laboratories are engaged in both industrial research and industrial development. These two classes of investigations commonly merge so that no sharp boundary can be traced between them. Indeed the term research is frequently applied to work which is nothing else than development of industrial processes, methods, equipment, production, or by-products."

Bichowsky[I-4] states that the word "research" has two rather distinct uses. "The first or general use is to cover all the processes whereby an invention is conceived and carried to the point where it can be turned over to production. It is this very broad use that one has in mind when one talks of industrial research, or the research laboratory.

"The second use of the word 'research' is a very specific use and refers to laboratory experiments concerned with the accumulation of data needed for engineering use, or with the establishment of a principle or theory that may be needed in understanding difficulties or suggesting developments. It is this second use of the word that the college professor has in mind when he thinks of industrial research, because this usage of the word is more in accordance with the use of the word 'research' in the university laboratory".

Then he adds that "There is a third kind of research which seems to many a sort of holy rite to be spoken of with bated breath. This is *pure* research.

"To justify pure research requires the same reasoning that is required to justify the most impure research. The difference is simply in the factor of time. Langmuir played with poorly evacuated bulbs because he or Whitney (in this case both) knew that new methods and new ideas were needed if lamps were to be improved. They didn't know what these ideas were.

"*Pure research* can thus be *poor* research, in the sense that it is born of desperation after everything intelligent has been tried. It may be poor research done by a very good man. Only when clear-cut, curious, practically-minded men like Langmuir do it can it succeed."

With four such distinguished scientists having so adequately defined "research" and "development", it appears presumptuous of the writer to give a fifth version. However, in aircraft laboratories three types of investigations are quite common:

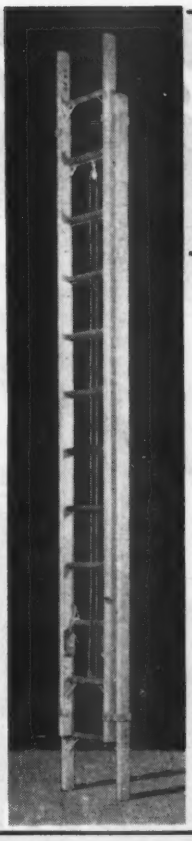
(a) Fundamental, academic, or *basic research,* which concerns long-range systematic investigations in the physical sciences primarily for extending man's knowledge of natural laws and principles, not initiated necessarily with any industrial application in mind.

(b) *Applied research* or *development,* which concerns the shorter-range applications of the results of basic research to a particular industrial product or enterprise, and

(c) *Testing,* which is the laboratory work essential to prove the theory evolved by basic research, to justify the industrial application of a development, or to control industrial processes and applications.

The writer, agreeing that the present war emergency has over-stimulated and over-expanded many research facilities beyond the economic point for postwar years, finds aid in considering the conditions of self-sustaining prewar research.

Perazich and Field[1-12], in studying the results of the questionnaire circulated to all research organizations in 1938, stated that "the type of research which is being done (in 1938) in industrial laboratories usually deals with the application of basic scientific knowledge to the problems of production of goods and services. . . From an economic standpoint of an individual company basic research is often of speculative value inasmuch as its findings may be impractical for the development of new products or services on a commercial scale. Although several large laboratories included in the 1938 survey are doing much work in the basic



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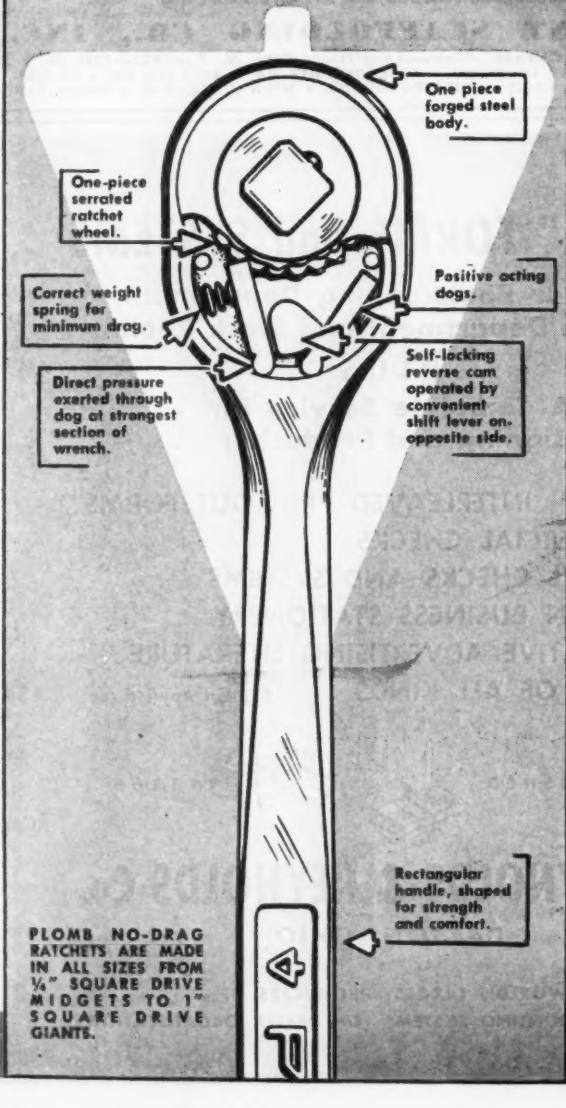
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sciences, this is not typical of industrial research in general. Today the centers for fundamental research are to be found primarily in government, university, and foundation-supported laboratories."

These men concluded that "the so-called commercial development phase of industrial research bridges the gap between basic and applied research, performed in a laboratory, and the production, sales, and advertising departments of a manufacturing concern."

Research vs. Testing

Certain of today's scientific leaders have clearly expressed themselves on the place of testing in industry. L. A. Hawkins,[I-3] executive engineer of the General Electric Research Laboratory, states that "research differs from testing as the work of an explorer or pioneer differs from that of the surveyor who follows him. Research is not the obtaining of more accurate data regarding what is already known. It is exploring the unknown for new generic facts or principles. Testing deals with existing things for their own sake. Research seeks the new knowledge which will make new things possible. Research may involve extensive testing, but the testing is only incidental, a means to an end. If nothing but testing is involved, the work never becomes research."

Standardization, factory process control, development, and testing are the applications of existing knowledge to the problems of industry. They are bound up with, and can exist only in connection with, industry; they represent applied science or engineering. Research, on the contrary, is essentially pure science, until engineering steps in to apply it.

T. A. Boyd,[I-1] of the General Motors Research Div., repeated the same thought when he stated that "The testing laboratory concerns itself merely about that which is already in existence, while the research laboratory is concerned about that which could exist, if only there were enough imagination and knowledge to bring it into being."

According to Bichowsky,[I-4] development and engineering are in some respects the antithesis of research. On the "car of progress", they are the brake and control mechanism. Without this mechanism, the "car" can't be safely driven; with too much of it, it never starts.

Now in industry there is another corporate activity which, in the executive's mind, tends to become confused with research. This is the group of activities, differently organized in the various industries, which include inspection, process control, specification, raw product approval, and final test.

There is nothing quite so different from research as the job of the man who looks for a defect in a casting or a finished piece, who notes whether all the steps in a process are correct, who specifies what grade of oil to use in a part, and who analyzes a shipment of steel for carbon; yet this function of control is very commonly confused with research.

Bichowsky attributes two reasons for this: First, that the operations of control (that is, the chemical analyses, the physical tests, and the final run-in test) usually require the same instruments that are used in the research laboratory, and thus are often performed in the same laboratory buildings. The second reason is that, as nearly every research director has found, it is very desirable to keep the closest contact with the department making inspection or tests because that department usually has the first and most accurate picture of the faults in existing equipment or products, or at least of those faults with which the research department is chiefly concerned. Kettering, with his gift for inspired simplification, has said that "the main task of research is to find out what's wrong with what you sell."

Research As a "Trouble-Shooter"

Inasmuch as aircraft research and development laboratories have not, to date, become as academic as some of the older and more experienced automotive laboratories but rather have concerned themselves with "test engineering" the contractual airplane, the lamentations of the basic research director on being exposed to the cold, cruel world come somewhat as a surprise.

Bichowsky[I-4] upholds the belief that "nearly every research director has at one time or another expressed the opinion that it is not the function of research to serve as a trouble-shooter or to correct faults of design or manufacture. In almost every research laboratory a very considerable part of the time is spent not on major projects of the inventive type, but on minor projects: The correction of faults of existing apparatus, the improvement of processes of manufacture and of tests, and the design and invention of minor improvements.

These are more properly the functions of other departments, but for various good or bad reasons they are given to research, as a sort of complementary service. Most of the reasons given why research should undertake trouble-shooting are bad, and the best organized research departments do a minimum of it."

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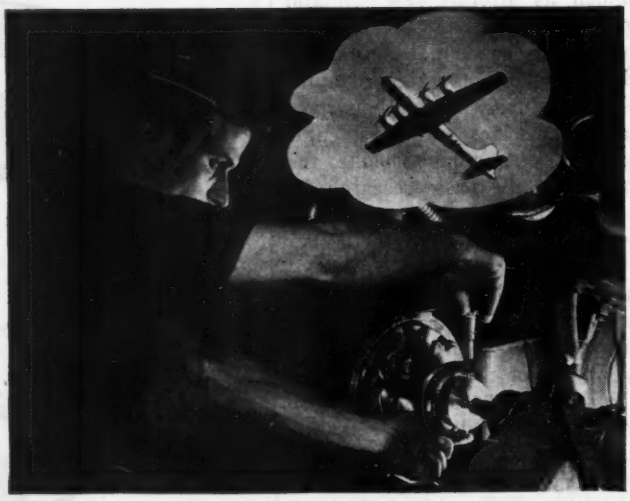

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conventional aircraft development laboratory and the basic research divisions of universities and of some of the larger laboratories in the automotive, electrical, and metal industries.

The slogan of the modern high-production aircraft laboratories could well be—"Keep the planes rolling off the line by solving *today's practical* problems *today*"; whereas that of the true research scientist cloistered away from the production line might be—"Investigate the *basic* problem for a better world *tomorrow*."

Both types of laboratories can complement each other in the postwar picture, if they are willing and able to pool their results and find a common meeting of minds.

References to Part I

For those readers who wish to study further the essentials of research and test engineering, the following references are offered.

Note: For added convenience in this series of articles, two numerals are employed in each reference key, the first numeral indicating the part number in the series and the second numeral being the reference number. Thus, (I-4) means "Part I, Reference 4."

(I-1) *Research—The Pathfinder of Science and Industry* by T. A. Boyd, Research Div., General Motors Corp., D. Appleton-Century Co., N. Y., 1935.

(I-2) *Glances at Industrial Research* by E. R. Weidlein and W. A. Hamor, Mellon Inst. of Industrial Research, Pittsburgh, Pa., Reinhold Pub. Corp., N. Y., 1942.

(I-3) *Engineering Development and Research* by L. A. Hawkins, Exec. Engr., Research Laboratory, General Electric Co., *General Electric Review*, Vol. 32, No. 2, Feb. 1929, pp. 86-94 incl.

(I-4) *Industrial Research* by F. R. Bichowsky, Chemical Publishing Co., N. Y., 1942.

(I-5) *The Elements of Research* by F. L. Whitney, Colorado State College of Education, Prentice-Hall, N. Y., 1942.

(I-6) *Industrial Research*, an address by C. F. Hirshfeld, chief of research, The Detroit Edison Co., delivered at Princeton University on Nov. 10, 1936. Published by The Guild of C. F. Brackett Lectures, 1938.

(I-7) *Unfinished Business*, lecture by C. F. Kettering, gen. Mgr., Research Laboratories Div., General Motors Corp. given in 1938 before Engineering Society of Detroit.

(I-8) *The Romance of Research* by L. V. Redman and A. V. H. Mory, Directors of Research, Bakelite Corp., D. Appleton-Century Co., N. Y., 1933.

(I-9) *Test and Research* by K. R. Jackman, Chap. 14 of *Introduction to Aircraft Design*, edited by T. P. Faulkner, McGraw-Hill Book Co., N. Y., 1942.

(I-10) *Profitable Practice in Industrial Research* by M. Ross, Harper & Bros., N. Y., 1932.

(I-11) *Philosophy of Research—Seed for Thought*, pamphlet published by Technical Data Dept., Research Laboratories Div., General Motors Corp.

(I-12) *Industrial Research and Changing Technology* by G. Perazich and P. M. Field, Report No. M-4, WPA, National Research Project, Jan. 1940.

(I-13) *Industrial Research Laboratories of the United States*, National Research Council, 7th Edition, Washington, D. C., 1940.

Buying a Used Plane?

(*Continued from page* 194)

give the entire wing a quick snap, with much the same motion one bounces a youngster on a seesaw. The wing won't fall off, not with the force we apply, but if we hear a rattle at the far end it may indicate cracked, loosened, or worn wing suspension fittings that aren't capable of coping with the aerodynamic overloads we'd hit in rough air.

Try this several times on each wing

to avoid being fooled by a slightly loose landing gear fitting. The landing gear fittings may be checked later by sharply striking each tire and by rocking the airplane rather violently while a friend who's come along with us watches and listens from a post near the landing gear-fuselage juncture or hinge point. Cracked main spars, while fairly rare, might evidence themselves by lack of snap and localized fabric wrinkles when you whip the wings.

Next, we shake each flight control surface with reasonable force. Loose hinge bushings, sloppy control rigging, worn control bearings, and minor damages will fairly shout their presence with rattles, rubbing sounds, and a feeling of undue flexibility. Here's a general rule: If it rattles, it should be examined carefully. Naturally, binding or excessive tightness are equally undesirable.

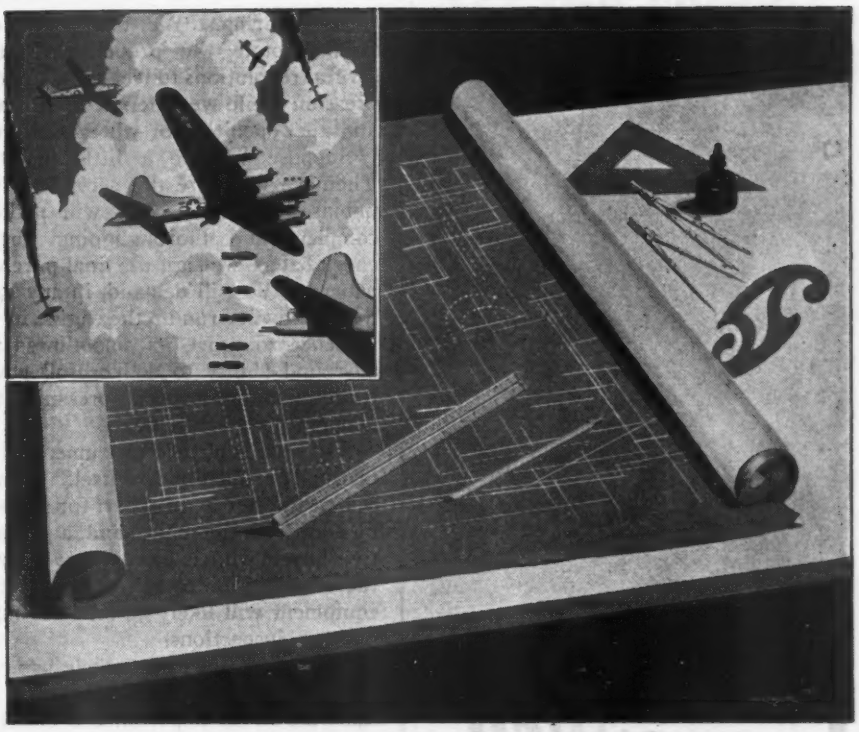
An "upholstery" check will give us reason enough to crawl into the cockpit. Then with both feet solidly placed on the rudder pedals, we rear back against the seat to place a load on the control cables. Still holding this load, we move each pedal for its full travel to force the cables into binding or rubbing conditions—if any exist. In the meantime, our friend grips first an aileron or wing control surface, then the elevators or horizontal control surfaces. Our attempted movement of the stick or wheel, while our companion holds the control flaps, will readily try out any excess slack in the rigging.

Further, an "apple tree" shaking motion may be applied to external wing struts as a check for loose fittings. Also, a knuckle or blunt fountain pen may be pushed against the fabric covering to check weak looking spots. Old and weathered dope will crack in a concentric pattern.

Of course, while taking notes under the proper headings, we have been careful to scribble down comments on such miscellaneous points as worn tires, torn upholstry, broken antennas, door latches, and cowl clamps. These are all small but annoying items.

Now to that major matter—the actual structural soundness and condition of the engine. This is the most crucial part of the ship to be inspected and checked out. Engines and engine repairs cost real money. We might overlook many fine points of appearance and detail if confident of buying a reliable and well-maintained engine.

After assuring ourselves that the propeller will not be a deadly guillotine (by checking the ignition switch for *off* position) we run our fingers along the varnished wood or polished metal blades to note any nicks or dents. Joggling the propeller will sometimes demonstrate a loose blade or engine



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thrust bearing. We then have our friend rotate the propeller through several revolutions to feel cylinder compression while we listen at the exhaust and inlet openings for wheezing valves.

Suppose we are a little doubtful. Then we will hire the services of an unbiased mechanic who will make a complete and thoroughgoing engine check before we sign the final purchase papers. We will demand, in any case, that the owner run up the engine in our presence to prove its smoothness and all-round ability to deliver full power while maintaining oil pressure and temperature requirements.

As for the plane's instruments, that matter is a full topic in itself. It may be best to refer to an expert for a check-up here. On the other hand, a prospective buyer who is licensed to operate radio and fly on complicated avigation equipment will likely be ready to make his own inspections.

Moreover, since this article has concentrated on the craft itself, we will not elaborate on the importance of checking the business angles of clear titles, freedom from encumbrances, and the general run of questions common to the sale of expensive property.

Now, while our memory of the various points is still fresh, we find a quiet spot and go about revising our notes into an orderly form, making any needed additions or corrections. This done, we strike for the nearest repair station for an estimate of the amount our airplane will cost over and above the prime purchase price. Regarding any questions concerning licensing, or relative to okays on alterations, we will await CAA advice before deciding to buy, or finally reject, the plane.

Making a wise choice when buying a plane is insurance for the real utility and pleasure that a private airplane can afford.

Plane Wise, Part Foolish

(*Continued from page* 119)

transmitters, lights, map cases, and incidental "luxury" items like ash trays, assist straps, etc.

D—Raw materials used in the manufacture and assembly of airplanes and needed for their complete maintenance and repair while in use. Some of these are, naturally, in more constant demand than others. In general, they include steel tubing, aluminum alloy sheets and extrusions, fabric, dopes and finishes, transparent plastics, etc.

In each class are found special problems of distribution different from every other. To date, the outlets for each overlap in only a very few cases. Seldom do we find an airplane dealer or distributor who is also a distributor for engines, instruments, hardware, and raw materials. Today, with no new private airplanes to sell, the so-called supply houses have come into their own.

Many of the present operators handling Class B, C, and D materials were formerly airplane dealers or distributors, and they now hope to participate in the expected airplane sales boom after the war. Many of them intend to maintain their present facilities for the distribution of standard parts, accessories, and maintenance materials, and in this respect they are heading in the right direction.

Parts and accessories manufacturers have several basic methods of distribution open to them, but each method should be aimed toward making the goods easily available to the ultimate consumer. Class A parts will undoubtedly be handled through the same distribution channels as new airplanes, but airplane distributors, dealers, and factory-branch men will be faced with the necessity of carrying a larger stock of manufactured airplane parts than in the past.

The successful operation of any one dealer may depend, to a large extent, upon his ability to render quick standard service on the airplane which he sells. The airplane manufacturer should recommend to the dealer the amount of Class A parts to be carried in stock at all times. Some manufacturers may have a provision in the dealer contract stating that the dealer must keep in stock parts which amount to 10 or 15 percent of the net value of the airplanes in his territory.

In any event, the stock of Class A parts carried by one dealer should be approximately equal to that carried by any other dealer in whose territory the same number of airplanes are operated. Proper handling of this part of the dealer contract should avoid long delays in the type of repair work which requires components which are available only from the manufacturer of the airplane.

Class A stock may also be handled by repair stations situated in territories where certain makes of aircraft are more numerous than others. It will be to the best interests of aggressive airplane distributors to see that all repair stations in their respective territories are always stocked with at least the minimum quantity of manufactured spare parts considered necessary for the complete overhaul and repair of one airplane of the make which they sell.

This will benefit the repair station by enabling it to take care of business which it might otherwise lose. The distributor also benefits because he is able to assure his prospects that they

can readily obtain complete service throughout his territory. Added to this is his share of the commission on Class A parts sold to repair stations in his territory.

The maximum commission on Class A parts should be greater than the maximum distributor discount for new airplanes—because of the necessity for more bookkeeping, wider ultimate distribution, and the greater quantities which must be carried in stock. In other words, more units are involved, placed in more locations, and each requires more clerical work than is the case with a complete airplane.

Sale of parts must be worth while financially if adequate distribution is to be expected. Class A parts could probably be sold to the distributor at a discount as high as 40 to 50 percent, with 15 to 25 percent margin to the dealer or repair-station man.

While aircraft manufacturers will undoubtedly prefer that their own factory parts are used in all cases where Class A parts are required, they nevertheless face the fact that cheaper substitute parts may, through other channels, also be made available to repair stations, and thus to owners.

This condition existed to a small degree prior to the war on such items as tailwheels and windshields. Such items, then, will be in Class B and may be purchased by aircraft manufacturers as standard parts which merely require different fittings for adaptation to any of their models. An increase in the number of standard parts which can be used on any particular airplane should contribute to lower costs, because the airplane manufacturer does not have to tool up and produce such parts.

In Classes B, C, and D, there are still other problems which should receive far greater thought than heretofore. In the past, some airport operators could buy Class D materials direct from the manufacturers, and discounts on Class B and C parts varied with the quantity purchased, with little or no consideration of the geographical distribution of final sales.

Thus, an operator at a large big-city field could earn maximum discount as a "distributor" without selling the parts or materials but by using them for his own maintenance.

All items in Class B should be available to customers through airplane dealers and repair stations. Aircraft manufacturers should be allowed to purchase quantities at full discount from the original source, permitting them to resell to dealers and repair stations at a profit. The present "supply houses" which have been selling Class B parts would still have a very definite market among airplane distributors, dealers, repair stations, and airport operators.

Some aircraft manufacturers, in planning a complete consolidation of parts and materials necessary to service their airplanes, have favorably considered the advisability of furnishing their distributors and dealers with items in Classes B, C, and D. Many such items, especially those in Classes B and C, would be trade marked with the name of the aircraft manufacturer, even though they were purchased from outside sources.

The tendency will be for the aircraft manufacturer to furnish all parts to his dealers and distributors for the sake of enabling them to render standard service with guaranteed factory parts. This means that even nuts and bolts, used by the manufacturer in assembling his aircraft, will be sold by him to his dealers and be given regular parts numbers.

Thus a mechanic who needs a landing gear bolt need only look at the "exploded" drawing of the landing gear in his service manual, identify the bolt by the airplane manufacturer's number, and then go to the stock bins where all parts for that particular make of aircraft are kept. This eliminates the usual trial-and-error methods and enables both the manufacturer and dealer to keep control of the quality of the parts used.

To what extent this method will be used will remain to be seen. If it is universally adopted, it will limit the extent of activity of the present "supply houses."

It has been rumored that at least one concern has considered the establishment of a separate parts-distribution company. It is assumed that such a subsidiary company would perform the spare-parts functions of the parent company's service department, and it would also distribute to distributors and dealers those parts and materials of all classifications which would be used in personal aircraft maintenance. If this system were followed by the larger manufacturers of personal airplanes, there would be fewer distribution problems, for the original suppliers of items in Classes B, C, and D—provided, of course,, that such distribution were adequate.

Engines, which we have placed in Class B, may prove to be an exception. It is reasonable to assume that some of the larger repair stations, staffed by expert aircraft and engine men, may qualify for dealership and distributorship of engines and engine parts. Aircraft power plants are actually items of original equipment and little sales work is involved in the consumer field.

Adequate service is of greater importance to the widespread acceptance of engines, and thus the proper distribution of service parts is the deciding factor. As the growth of private flying

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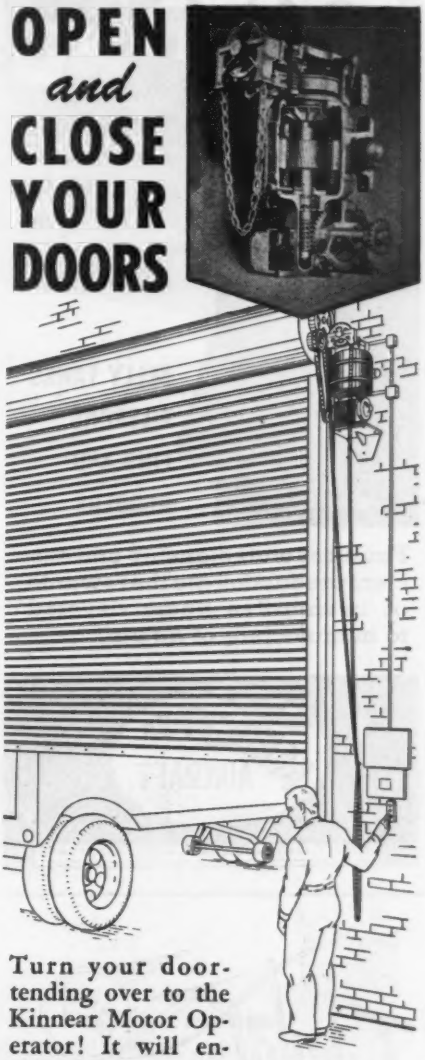

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SAVING WAYS IN DOORWAYS

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develops, we may well expect to find the "supply houses" carrying stocks of all parts for the most popular engines. Thus, a repair station operator could order essential parts, for various engines in his shop, from one source instead of from several engine manufacturers or their authorized distributors or dealers.

Such outlets as the "supply houses," or perhaps specialized engine parts jobbers, seem best fitted from a distribution standpoint to overcome present distribution problems of making more parts available nearer to the points of actual need.

To a marked degree, the same is true of Class D materials which are necessities for repair and maintenance. It is logical to assume that the best retail outlets for such materials will be the repair stations, because, by nature of their operations, they will use tubing, fabric, and dope in greater quantities than will the distributors and dealers of aircraft. Naturally, there will be considerable dovetailing here, since many distributors and some dealers of aircraft will provide much more extensive repair facilities than before the war.

Thus, the manufacturer of Class D materials will do well to consider the aircraft manufacturers, the "supply houses," and the repair stations as his best outlets, with emphasis on repair stations for the immediate future.

The points brought forth above represent the writer's analysis of the distribution of parts, as based upon prewar practices, current practices, and reported postwar trends. As the conversion to postwar operations takes place, various unforeseen changes will surely occur, but these changes will be largely dependent upon the extent to which aircraft manufacturers enter into the distribution of parts, accessories, and materials, and they will also depend upon the quality of substitute parts and accessories manufactured and marketed by others.

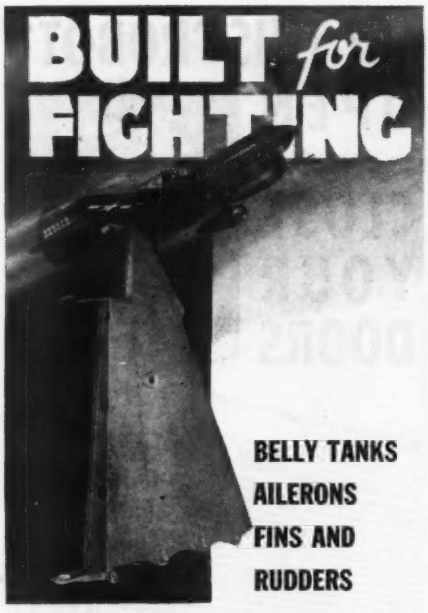
Book Reviews

(*Continued from page* 172)

of World War I: "Never again dare the people of the world allow air power to be used without restraint by mad dreamers of world conquest." Further, he warns against effects of possible monopolies of the air.

AIRPORT ENGINEERING, by H. Oakley Sharp, G. Reed Shaw and John A. Dunlop. J. Wiley & Sons, Inc., N. Y. C. 150 pages, charts, photos, index. $5.

Comprehensive work designed for students of engineering, relating to problems of airport construction, both in the present and postwar periods. It is stated that "air transportation in peace and war has reached the point in its progress where special engineering consideration must be given the ground facilities which serve as the connecting link between surface and air transportation." Profusely illustrated.



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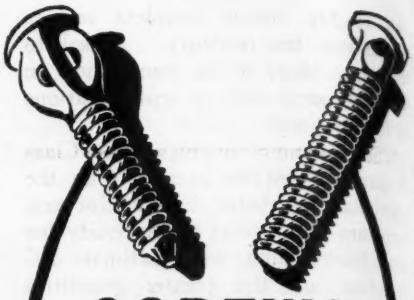

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THE AIR FORCES READER, edited by Norman Carlisle. Bobbs-Merrill Co., N. Y. C. 406 pages, photos, index. 3.75.

Broad coverage of U. S. Army, Navy, and Marine Corp aerial participation in World War II. Volume is built about four main divisions: The Air Forces, The Men, The Materiel, and Air Forces in Action. Treatment is graphic.

A BIBLIOGRAPHY OF AVIATION MEDICINE (Supplement) by P. M. and E. C. Hoff and John F. Fulton, M. D. Committee on Aviation Medicine, Div. of Medical Sciences National Research Council, Wash., D. C. 109 pages, index. $2.50.

Supplementary listing of literature bearing on aviation medicine in all phases, including history, special physiology and pharmacology, psychology, aeromicrobiology, training, therapeutics, special problems, and organization. Most of items listed are concerned with present period of aviation progress.

ROCKET RESEARCH, by Constantin Paul Lent. Pen-Ink Pub. Co., N. Y. C. 120 pages, diagrams, photos, index, and patent list. $5.

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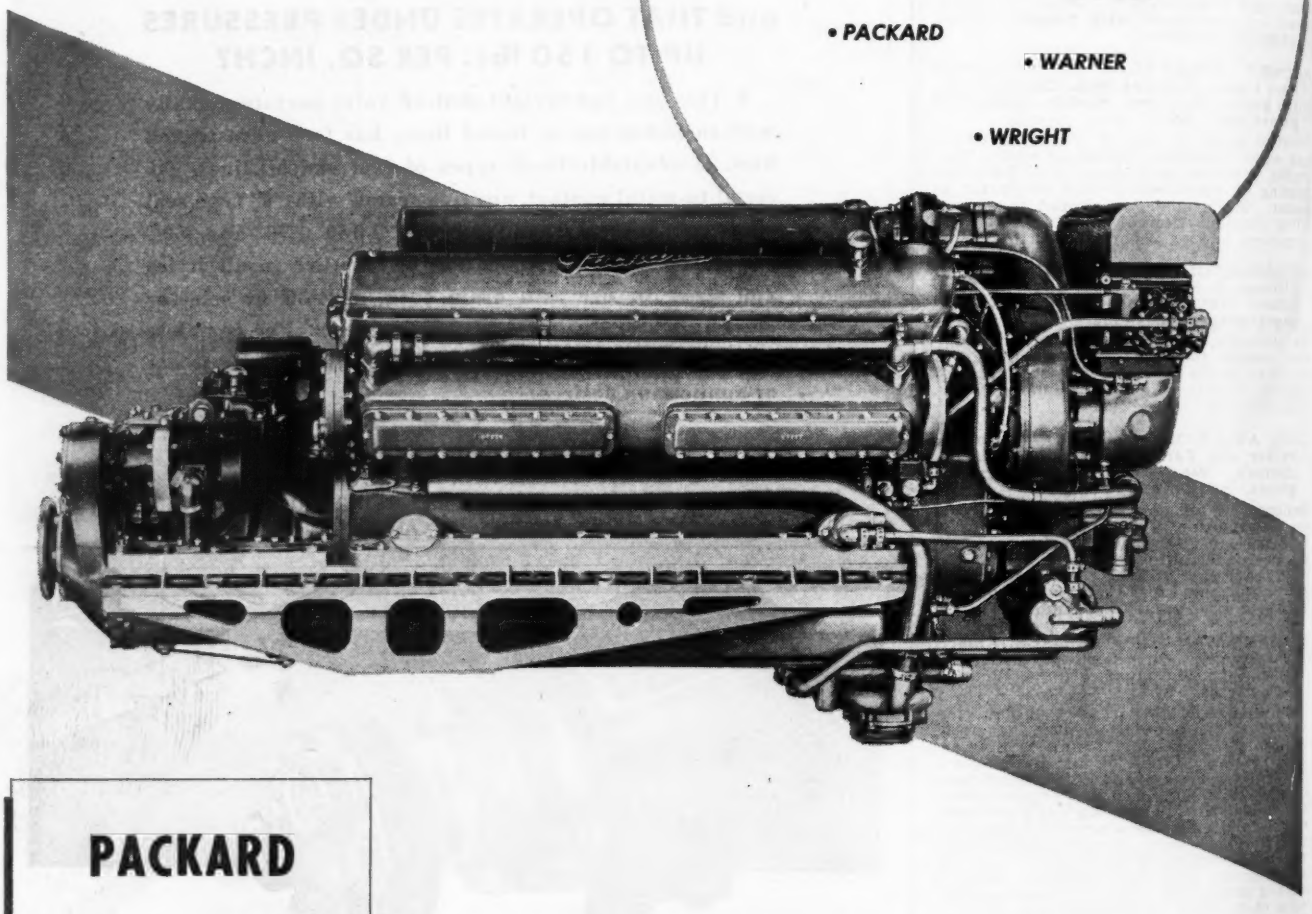

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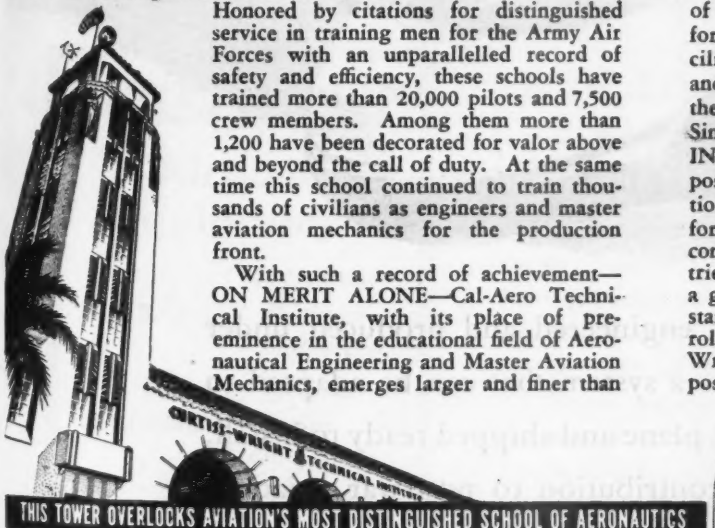

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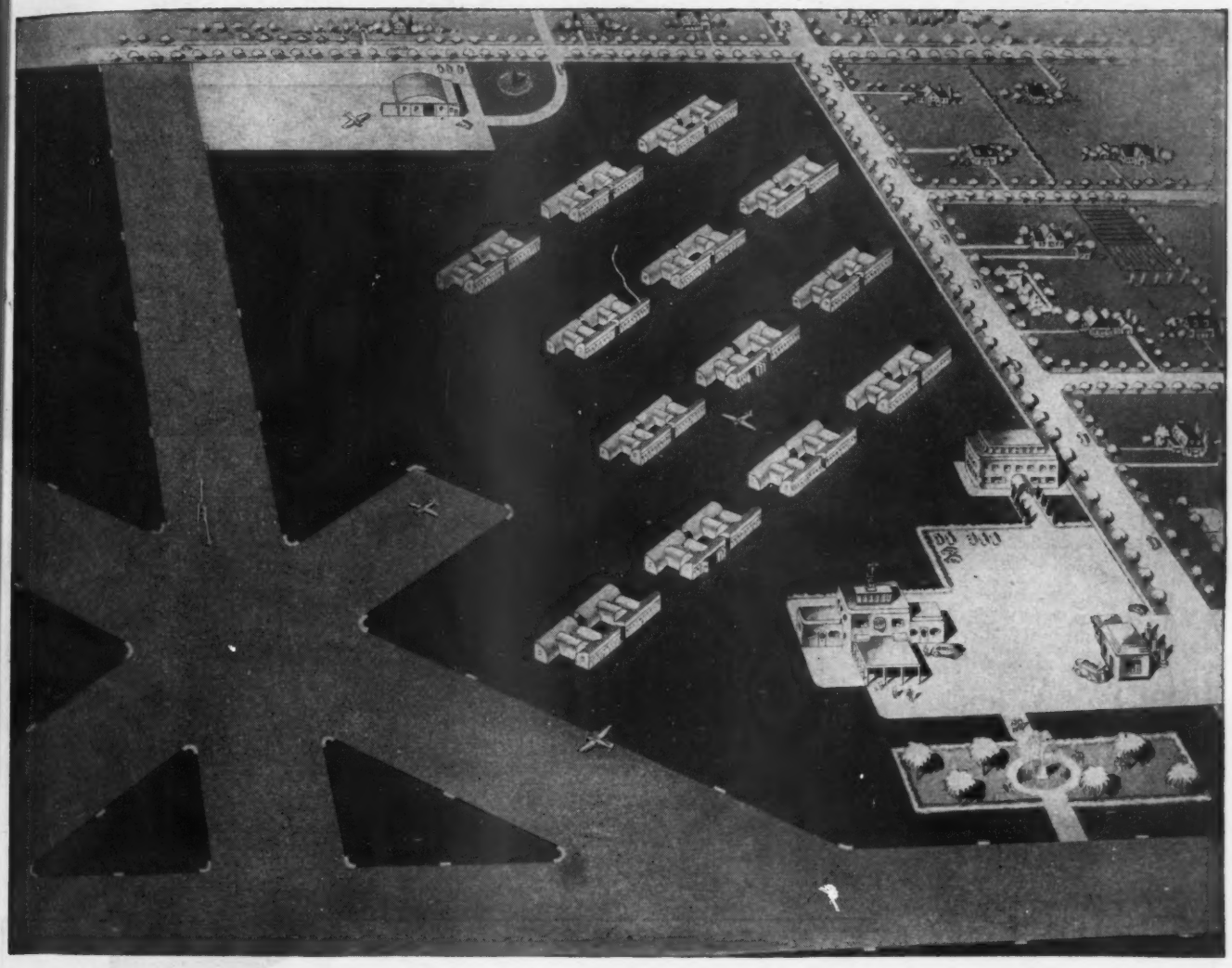

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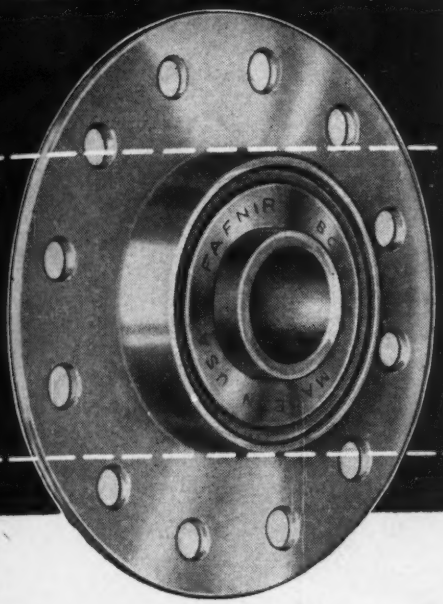

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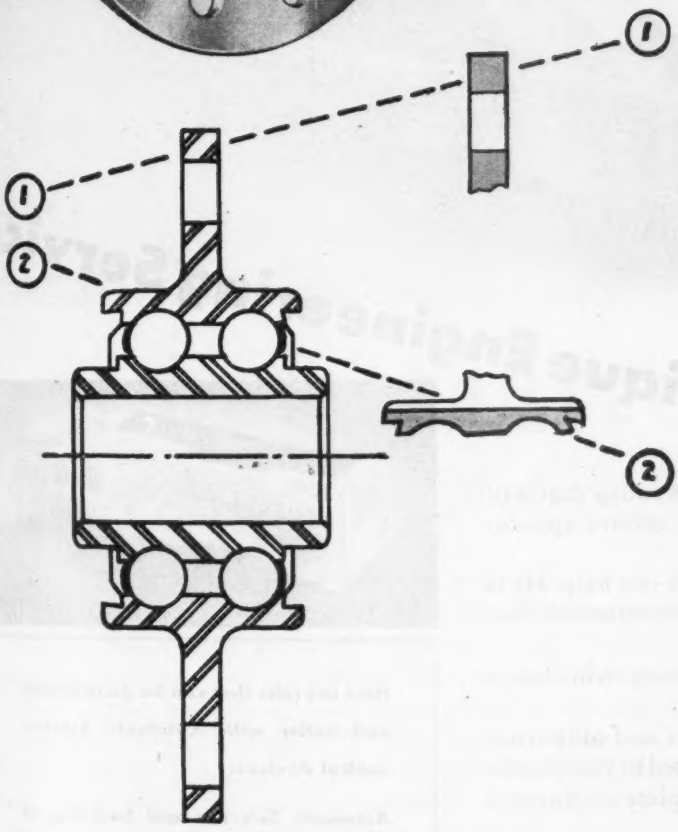

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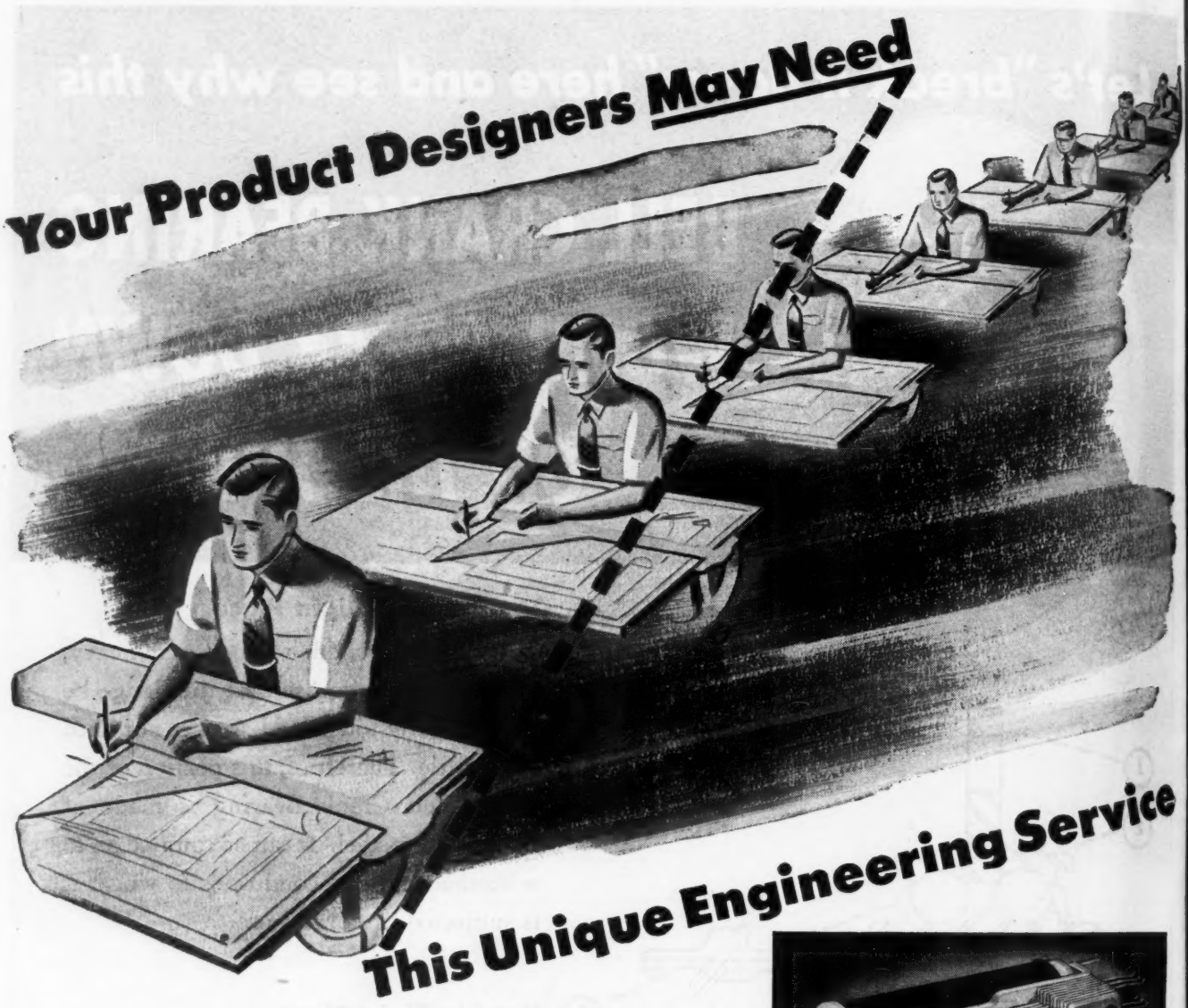

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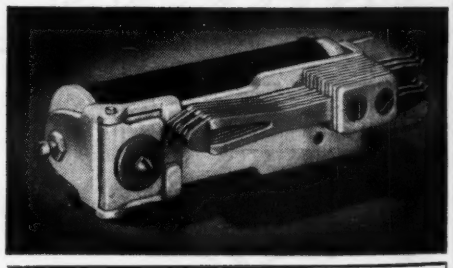

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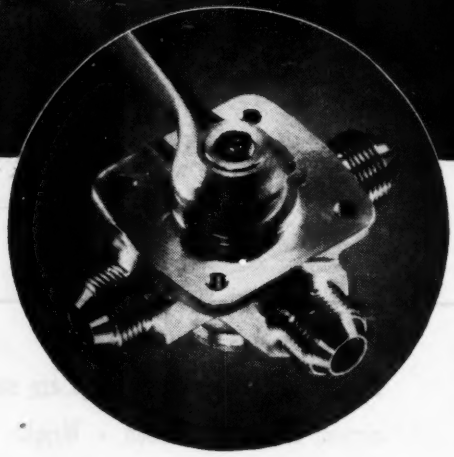

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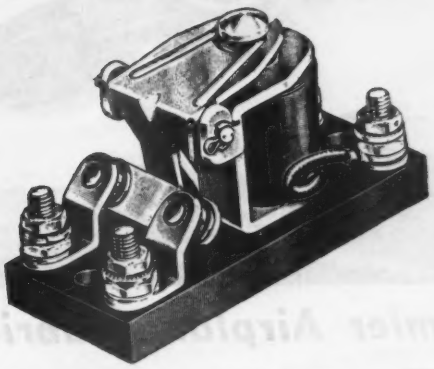

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America's incomparable planes represent more than the assurance of Victory in the present war by their superiority and the tremendous numbers in which they have been put in the air.

They symbolize our *future security* — by the manner in which American industry and labor can produce a more powerful war machine than any enemy nation or group of nations. This big, stubborn fact — gratifying to us — is one with which foreign powers who may contemplate attack on America or conquest affecting American interests will always have to reckon.

At Kropp Forge we are very proud of our contribution to the history-making planes named here — super-tough drop forgings for the parts which must withstand the terrific tensional, torsional and compression stresses of flight and combat. When the number of aircraft on order necessitated the rapid delivery of such drop forgings in unprecedented quantities, our large new plant was built for the exclusive production of aviation drop forgings, of which we have furnished "plenty and on time" for America's triumphant air effort.

The inquiries of plane and landing gear and engine builders are solicited.

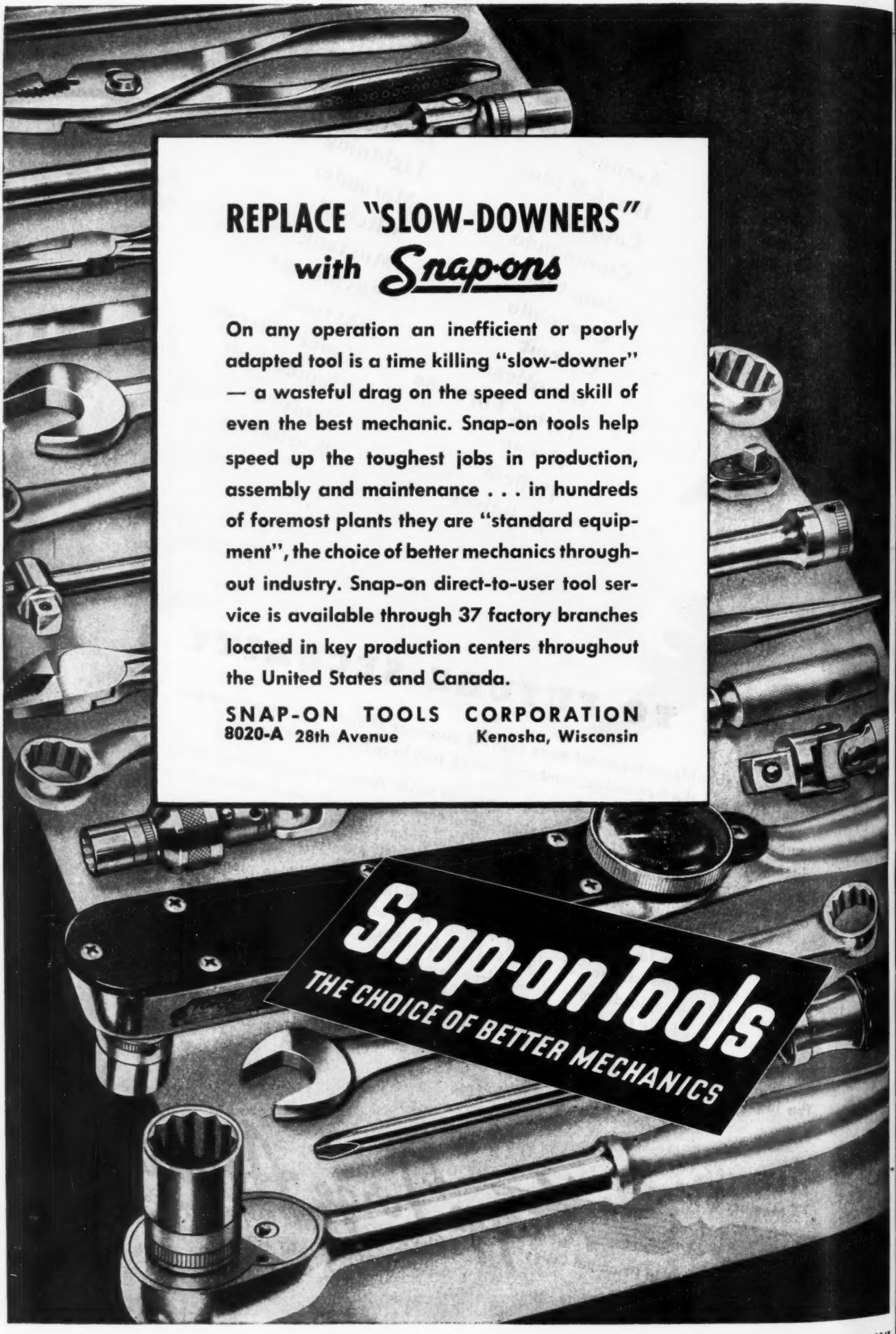
Member of the A.C.C.A.

Kropp Forge Aviation Co.

Division of The Kropp Forge Company

5301 W. ROOSEVELT ROAD, CHICAGO (50)

Engineering Representatives in Principal Cities



REPLACE "SLOW-DOWNERS" with Snap-ons

On any operation an inefficient or poorly adapted tool is a time killing "slow-downer" — a wasteful drag on the speed and skill of even the best mechanic. Snap-on tools help speed up the toughest jobs in production, assembly and maintenance . . . in hundreds of foremost plants they are "standard equipment", the choice of better mechanics throughout industry. Snap-on direct-to-user tool service is available through 37 factory branches located in key production centers throughout the United States and Canada.

SNAP-ON TOOLS CORPORATION
8020-A 28th Avenue Kenosha, Wisconsin

WELDING INNOVATION BRINGS

40% INCREASE

IN A VITAL PRODUCTION STEP

Ryan technicians, in their endless quest for greater efficiency and lower costs in airplane manufacture, are continually seeking out, improving and putting to new uses equipment and methods not previously used in aircraft work.

Take welding, for example. Ryan attained a 40% increase in efficiency in welding the thin gauge stainless steels used in aircraft by adapting atomic hydrogen arc welding, for the first time, to the fabrication of many important airplane parts and assemblies. New, lightweight electrode holders, specially alloyed steels and the use of a "controlled atmosphere"—all Ryan developments—did the trick.

This resourcefulness is typical of Ryan ingenuity in seeking out and applying newer methods and improving existing ways of doing things. In wartime, this means superior quality and greater production at lower cost to the taxpayer—in *big* as well as *little* ways. In peacetime, it will mean lower initial and operating costs for the improved products coming from Ryan production lines.

THE PROBLEM: When stainless steels were introduced in the manufacture of specialized parts for airplanes the headaches of welding were increased many fold. Thin gauge stainless steels required far more care than materials previously used and, at the same time, output needed to be stepped up to a high level. Ordinary welding methods were too slow and quite often were accompanied by scaling, burning, flux pockets and porosity.

THE SOLUTION: Ryan laboratory experts explored the entire welding field and found the solution by adapting the atomic hydrogen welding process. Using hydrogen (which excludes oxygen), they found, does away with porosity. Atomic hydrogen brings intense heat to the immediate surface without undue change in the metal structure—and there is little loss of the vital stabilizing elements of Columbium and Titanium. In addition the use of Ryan's "controlled atmosphere" method eliminates the need for flux.

THE ADVANTAGE: Atomic hydrogen lends itself to high-speed welding. Women can use it, after a few short weeks of training, with sureness and safety. It eliminates the prevalent defects of scaling, burning, flux pockets and porosity and increases the welding output of thin stainless steel parts 40%.

RELY ON RYAN
TO BUILD WELL
1922 - 1944

RYAN *Airplanes*

BETTER PLANES *faster* Through Production Ingenuity

Ryan Aeronautical Company, San Diego — Member, Aircraft War Production Council, Inc.

DESIGNERS AND BUILDERS OF NAVY FIGHTING PLANES AND EXHAUST MANIFOLD SYSTEMS

This is the eighteenth of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME.

"Will Aviation's Blueprints be 'Scraps of Paper'?"

asks ERNEST R. BREECH, President, Bendix Aviation Corporation

AVIATION'S PLANS *for the postwar era look very promising—on paper. These plans call for several thousand new airports . . . greatly expanded domestic and transoceanic schedules . . . flying made safer and easier than the public now thinks it is . . . tourists traveling by air . . . and millions of young men taking to wings.*

"But none of these hopes will come true unless the conditions are favorable . . . unless reconversion is orderly and constructive . . . unless public policies are wise and fair . . . unless tax rates favor the public's buying power . . . and the American standard of living remains high enough to encourage the growth of new industries.

"And who can create the conditions that will turn Aviation's blueprints, not into scraps of paper, but into realities? Men in Aviation can't do it alone. We need the cooperation of Government, labor and the public. With that, aviation can do for the nation what the railroads did after the Civil War and the automobile did after World War I."

Yes, Mr. Breech, aviation's plans for the future must be supported by the whole U. S. A. . . . but first they must be *sold* to the whole U. S. A.

And the first place to sell them is to the "test pilot" market—the people who (in business or in private living) are habitually first to accept any change for the better.

This is the market aviation thinks of when it thinks of the more than a million TIME-reading families—who are America's best prospects for planes and air travel—whose positions in American business make them the natural national vanguard for any programs aviation may set up—who vote TIME their favorite magazine 7 to 1 over the runner-up.

Believing that the ideas of aviation's leaders are always of interest to the aviation industry,
TIME here gives them wider circulation
in the name of

AVIATION'S SILENT PARTNERS

TIME

THE READERS OF TIME

"Seabee" Balaban and his father helped build many a Studebaker in peacetime

And they're comrades in craftsmanship still

Studebaker's Joe Balaban has another son and a daughter in the Navy—Like thousands of Studebaker automotive veterans, Joe Balaban now works in one of Studebaker's aircraft engine plants. Other Studebaker automotive veterans build heavy-duty Studebaker military trucks and Weasel personnel and cargo carriers.

KEEP ON BUYING WAR BONDS AND KEEP ALL THE BONDS YOU BUY!

THE whole nation is justly proud of the accomplishments of our Navy's fighting construction battalions known as the Seabees.

One fine example of the resourceful Seabees at their best is First Class Seaman Milan Balaban of South Bend, Indiana. He learned his way around with tools as an apprentice millwright in the Studebaker automotive plants—working close by his father who has been a Studebaker employee for more than 26 years.

Today, Joe Balaban, the father, is putting his skill and experience to good account in the Studebaker Aviation Division—from which tens upon tens of thousands of Studebaker-built Wright Cyclone engines for the famous Boeing Flying Fortress have been steadily streaming forth.

It's largely because of the painstaking craftsmanship in peacetime, of numerous Studebaker father-and-son teams like the Balabans, that wartime America is getting such dependable performance from Studebaker motor cars and motor trucks.

Awarded to All *Studebaker Plants*

STUDEBAKER

Building Wright Cyclone engines for the Boeing Flying Fortress—heavy-duty Studebaker military trucks—the Weasel personnel and cargo carriers.

NUGGETS

—the Name of an

ENTIRELY DIFFERENT KIND OF SOCKET WRENCHES

NUGGET Socket Wrenches are revolutionary! They offer the FULL RANGE of sockets and handles in ONE DRIVE *for all work which otherwise requires wrenches in TWO DRIVES.* All need for 3/8" and 1/2" wrenches is abolished. Since many of the socket sizes and handle types in the 3/8" drive are the same as those in the 1/2" series — it is obvious that the NUGGET DOUBLE-DUTY DRIVE will reduce your original investment, lower replacement cost and make you even more efficient . . . The secret of NUGGETS begins with exclusive Hexite Steel which is 33⅓% stronger than regular high-grade wrench alloy steels. It permits a wrench with *the strength* of bulkier 1/2" drive tools but the *practical compactness* of the 3/8" series . . . Thousands of mechanics bought NUGGETS before the war, but Hexite Steel is needed today in critical war equipment. NUGGETS will be back when Hexite Steel is available again. So don't buy old-fashioned wrenches now unless you absolutely need them. Wait for NUGGETS!

***A product of* BLACKHAWK MFG. COMPANY, Dept. W2115, Milwaukee 1, Wisconsin**

TO PRESENT NUGGET OWNERS: *If you have lost any of your NUGGET Wrenches, see your Blackhawk Jobber. He will arrange delivery of the replacements. Blackhawk wishes to protect the investment of present owners, even though Nuggets cannot be made and sold on a mass scale to new buyers until after the war.*

BLACKHAWK NUGGET SOCKET WRENCHES

THE WRENCHES THAT SMASHED TRADITION

Get Reliable Circuit Protection with KLIXON Aircraft Circuit Breakers

Taking off or landing on a postage-stamp airfield, hovering just above the ground in rescue work, or directing artillery fire in combat, Sikorsky Helicopters are capable of performing outstanding service in the home and on the battle fronts.

To protect the nerve systems, Klixon PSM Aircraft Circuit breakers (Army #43A8304) are used in the electrical circuits of the famous Sikorsky Helicopters . . . the R-4, R-5 and R-6. These reliable accurate breakers guard the planes and pilots by protecting the electrical system from possible damage caused by shorts and sustained overloads.

Klixon Breakers are compact, lightweight . . . are unaffected by shock, vibration, motion or altitude. They contain no complicated, fussy parts such as relays, toggles or magnets. That's why they operate surely and accurately under all flying conditions. They are available in all types . . . switch, push-pull, automatic reset, remote control and others. Bulletins giving sizes, weights, dimensions and performance characteristics are available on request. Write for copies.

Control panel of the Sikorsky Helicopters showing the installation of Klixon PSM Aircraft Circuit breakers (Army #43A8304).

KLIXON CIRCUIT BREAKERS

SPENCER THERMOSTAT CO., ATTLEBORO, MASSACHUSETTS

Seven years ago we started out as a west coast distributor of aircraft parts. We named our company Aircraft Accessories Corporation. ● Then we started developing aircraft hydraulics. The next thing we knew we were full-fledged manufacturers—and out of the parts business. ● Later, someone came along with an embryo electronic plant in Kansas City. Being young and ambitious—we bought it. To everyone's amazement—and somewhat to our own—we made it grow. And pay.

NEW NAME NEW HORIZONS

We're still young, ambitious. Our explorations in hydraulics, electronics and other fields promise post-war growing pains. And so we've outgrown our name. ● Aircraft Accessories Corporation no longer adequately describes our operations. We couldn't think of a name that did. So we coined one: **Aireon.** It's a name that's partly aircraft, partly electronics; but it will be largely what we make it. We hope—and intend—to make Aireon worthy of a place among America's most honored corporate and trade names.

Aireon MANUFACTURING CORPORATION
formerly AIRCRAFT ACCESSORIES CORPORATION

Radio and Electronics • Engineered Power Controls

NEW YORK • CHICAGO • KANSAS CITY • BURBANK

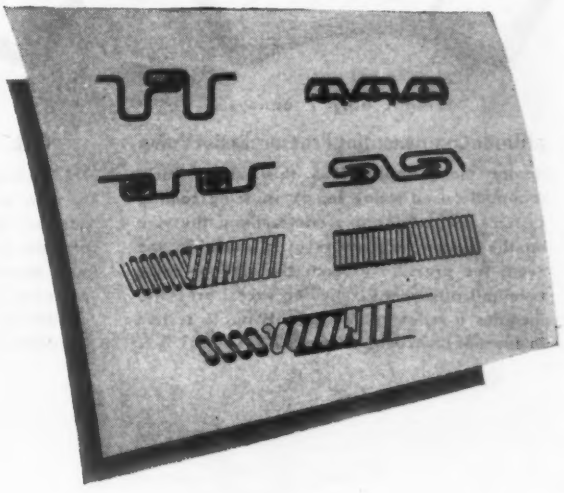
Breeze Flexible Conduit

for shielding or ducts

Breeze Flexible Tubing, manufactured in many diameters from a wide variety of metals, is used as ventilation and exhaust ducting in industrial, aircraft, marine and automotive applications. The same basic tubing, with the addition of a braided metal covering, becomes light-weight shielding conduit, used extensively for shielding ignition systems and any electrical circuit to insure dependable radio communication.

Manufactured from a continuous strip of metal, Breeze Flexible Tubing and Conduit can be furnished cut to length, with necessary end-fittings for any conduit installation.

Many different types of interlock construction — plain, packed, and soldered—are available to meet varying use requirements. A few of these are illustrated below.



Breeze BREEZE MARK

CORPORATIONS, INC.

Newark, New Jersey

Weight only 7 ounces

Altitude Compensating Pressure Relief Valve

Having many applications, this valve is most commonly used today for pressurizing cooling systems. Maintains a predetermined pressure on the system regardless of altitude. In the event the pressure exceeds the setting, valve automatically opens, relieving excess pressure. Includes a relief valve—admits air to system in event of a vacuum. Overall: 2 9-16" x 1 7/8".

Weight only 6 ounces

OIL PRESSURIZING VALVE

This valve maintains a pressure on the oil system, preventing cavitation of oil. Incorporated in the device is a relief valve which provides for relief in the event a negative pressure develops in the system. The operating pressures for this valve can be furnished to customers' specific requirements. Overall dimensions: Length 5 7/8"; width 3"; height 2".

Weight only 2 1/2 ounces

PRESSURE RELIEF VALVE

This valve, commonly used in aircraft engine cooling systems, maintains a predetermined pressure, expelling excessive pressures to the atmosphere. It incorporates a relief valve, preventing negative pressures in the system. Overall dimensions: Length 3"; width 1 1/2"; height 1 3/4". For detailed specifications on any one or all of these controls, write or wire.

Keep Backing the Attack

Controls for Aircraft Engines

Designed for *Maximum Performance*

. . . plus *Minimum Size* . . .

and *Minimum Weight*

As the efficiency of combat aircraft is increased, more and heavier equipment is continually being added — heavier armor and armament — auxiliary fuel tanks for longer range —new instruments for improved performance and protection. Yet, to meet today's demands for versatility — to function effectively and efficiently in any altitude—the power plants of all modern aircraft require precision controls such as the three Standair products illustrated and briefly described in this spread. However, the weight of all Standair controls has been reduced to the *minimum*. Standair engineers with the "know how" have successfully combined *maximum performance* in the engine controls of their design with *smallest possible overall size and least possible weight.* Standair instruments are being specified in today's efficient fighting craft, and the engineering skill responsible for these exclusive instruments for war will contribute to the development of similar controls for commercial cargo and transport planes when the war is won. Write or wire for complete specification and installation data.

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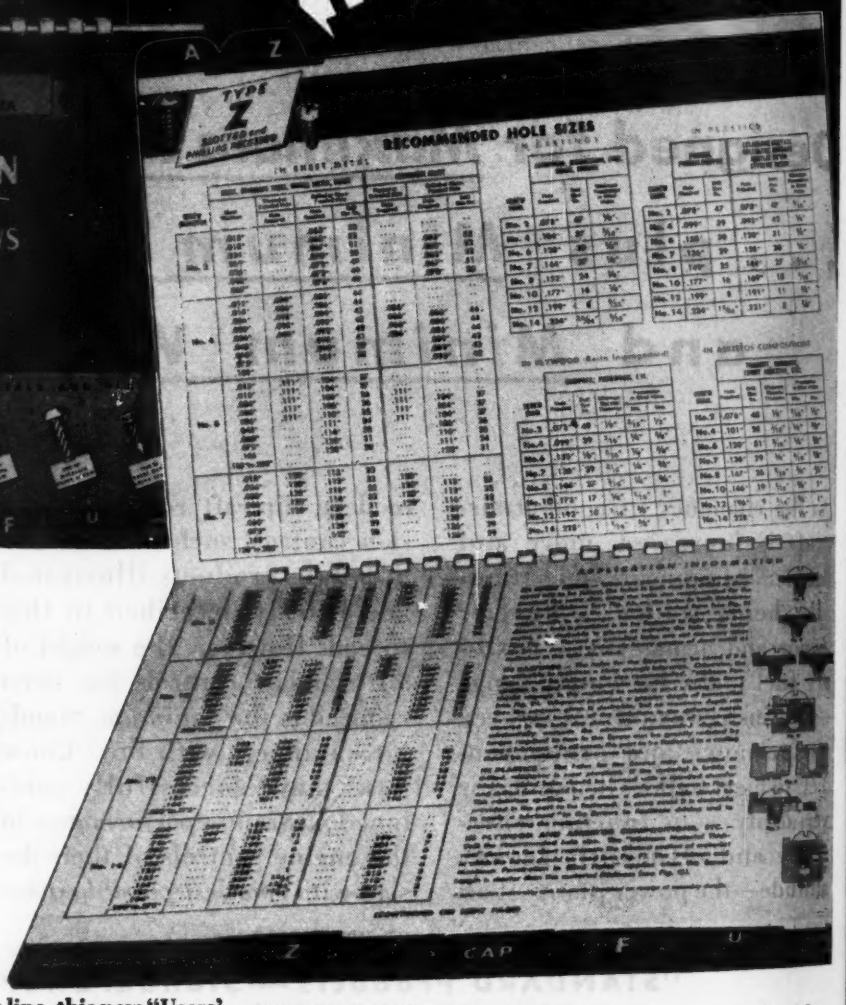
STANDAIR

Keep Buying War Bonds!

IF YOU USE SELF-TAPPING SCREWS

You Need this Valuable Guide

FREE to Designers, Engineers, Production Executives



WRITE FOR IT.. The chart is plastic spiral bound to open flat. Closes to file size. Has a strong hanger for wall use. A copy will be sent to any engineering or production executive who requests it on a business letterhead. Write to Parker-Kalon Corp., 210 Varick Street, New York 14, N. Y.

•

On the drafting board, or on the assembly line, this new "Users' Guide" will tell you *at a glance* WHAT TYPE of Parker-Kalon Self-tapping Screw to use . . . WHERE and HOW to use it.

All the facts you need are given in only 18 pages of quick-reading tables, charts and detail drawings. You see which of the various types of P-K Self-tapping Screws will give best results in the various gauges of sheet metal, stainless steel, structural steel, various castings and forgings, in the different types of plastics and compositions, in plywood, etc., etc.

You are shown the type of hole, the size of hole, the drill size that is best for the different screw sizes and for different conditions. Other tables give you screw sizes, recommended depth of penetration, head dimensions. Also included are tables of decimal equivalents; details on special screws and head styles; practical production hints on the use of Self-tapping Screws.

This handy chart will answer the question – "Where can I use the simpler P-K Self-tapping Screw method to save man-hours, speed work, cut cost, increase security. It will help get better results from the Self-tapping Screws you now use.

SELF-TAPPING SCREWS FOR EVERY METAL AND PLASTIC ASSEMBLY

PRAISED BY PROMINENT PLANT MEN . . in companies like Frigidaire, Iron Fireman Mfg. Co., Sylvania Electric Products, Farnsworth Television and Radio Corp., Schick, Inc., Brockway Motor Co., Bendix Radio Div., Bethlehem Shipbuilding Div., Sperry Gyroscope Co. *Typical comments:* "Will be a great help in our work" . . . "Proven indispensable – we need 4 more copies" . . . "Very useful because of its condensed information and intelligent presentation – would like 6 more" . . . "A remarkable handbook" . . . "Will prove invaluable in our design and production" . . . "Best thing of its kind we have ever seeen" . . . "Very compact and comprehensive" . . . "Of inestimable value."

PARKER-KALON
Quality-Controlled
SELF-TAPPING SCREWS

to warn

to challenge

to command

Official U. S. Navy Photo

E. A. aircraft lights flash their signals from plane to plane—from sky to earth—to form battle lines—to bomb enemy strongholds—to bring the squadron safely home.

E. A. Wing Tip Position Lights, Tail Lights, Formation Position Lights, and Recognition Lights are for action in mid-air—swift, sure, and fateful! They augment and supersede radio transmission, as trumpet supersedes field telephone when the battle is joined. In the black night they flash signals and commands; unfailing, unerring—for victory, for the lives of crews, for safe and happy landings.

E. A. Laboratories build for service, in war or peace, and for assurance of instant, certain action, and security from failure. High precision and accuracy, through skilled craftsmanship, have established E. A. Laboratories' leadership in war and peace; and after Victory that leadership will set new standards and ideals for the industries and utilities it is privileged to serve.

E. A. LABORATORIES, Inc. • BROOKLYN, N. Y.

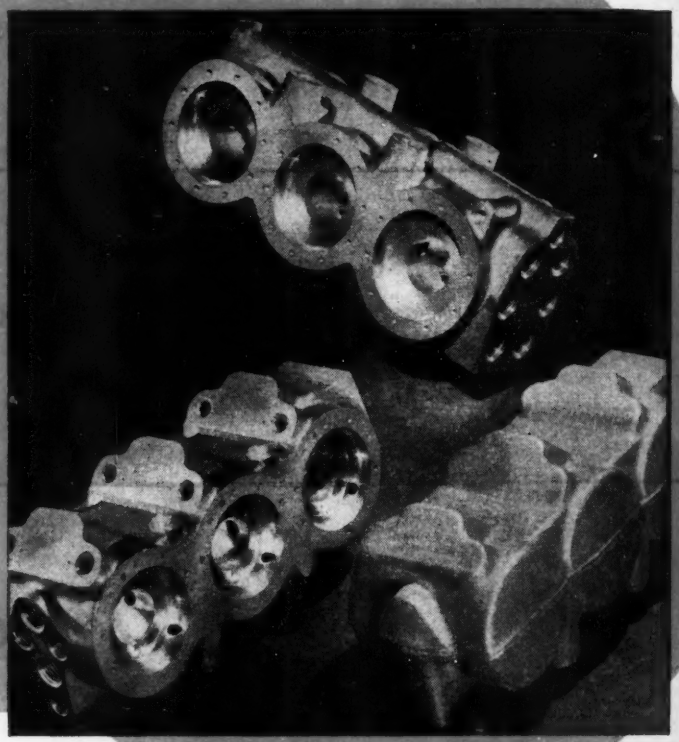
MAKERS OF AUTOMOTIVE, AVIATION, BICYCLE and MARINE APPLIANCES

FORGED

for soundness

MAGNESIUM

for light weight



Typical of many wartime products of American Magnesium Corporation is this forging, machined as you see it here into a part for an automatic pilot. It is very light in weight, magnesium's outstanding characteristic. It is sound, because it's a Mazlo forging. It provides excellent machinability, a property of all magnesium alloys.

Magnesium forgings enable you to achieve the ultimate in lightness with safety, because of their high strength-weight ratio. Many a warplane carries evidence of the dependability of these magnesium products.

In addition to forgings, ranging in size from tiny pieces to those weighing many pounds, American Magnesium is producing mag nesium alloy products in all other forms; sand castings, permanent mold and die castings, screw machine products, shapes and sheet. More than twenty years of experience in fabricating magnesium goes into these dependable products.

If you are wondering about ways of utilizing the weight-saving ability of magnesium alloys to best advantage, our engineers will gladly assist you. Write Aluminum Company of America, Sales Agent for Mazlo Magnesium Products, 1713 Gulf Bldg., Pittsburgh 19, Pa.

MAGNESIUM **MAZLO** PRODUCTS

AMERICAN MAGNESIUM CORPORATION

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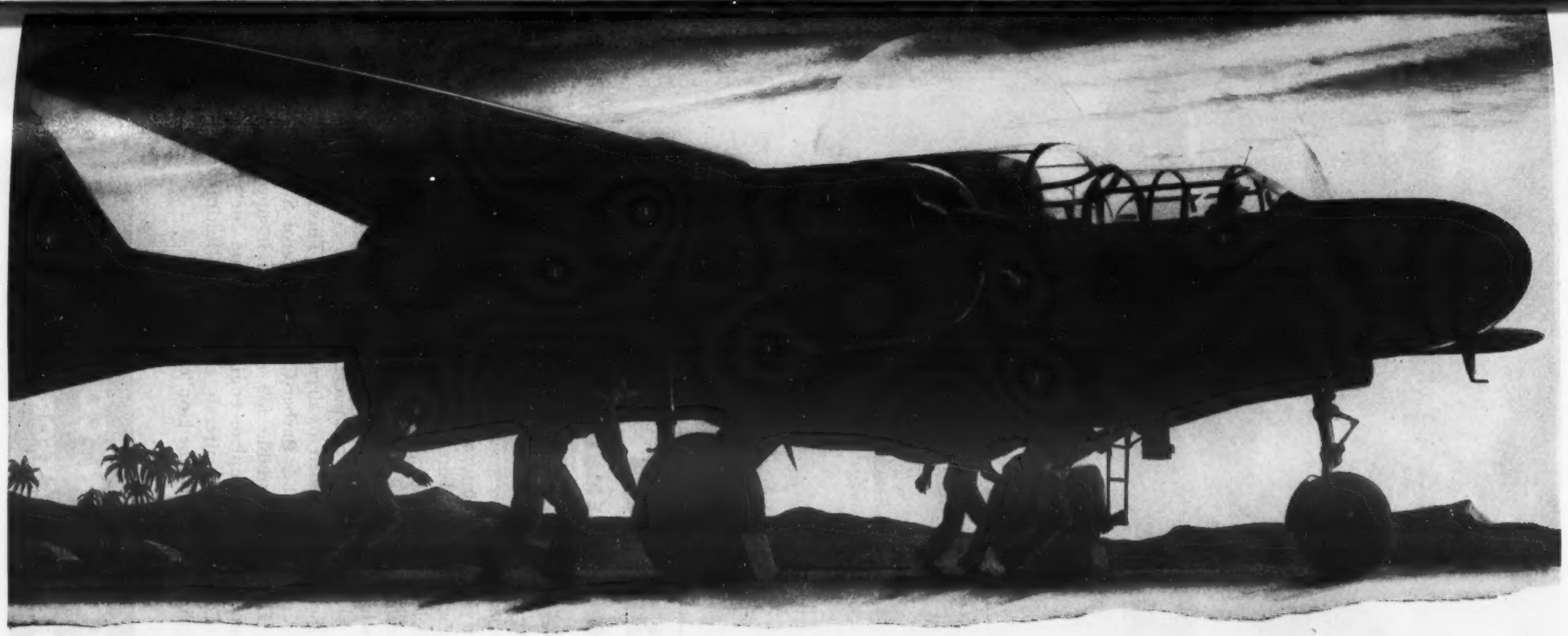


Big as a bomber, fast as a fighter . . . the first U. S. warplane ever designed especially for night fighting

NORTHROP BLACK WIDOW P-61 NIGHT FIGHTER

NORTHROP AIRCRAFT, INC.
NORTHROP FIELD, HAWTHORNE, CALIFORNIA
MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

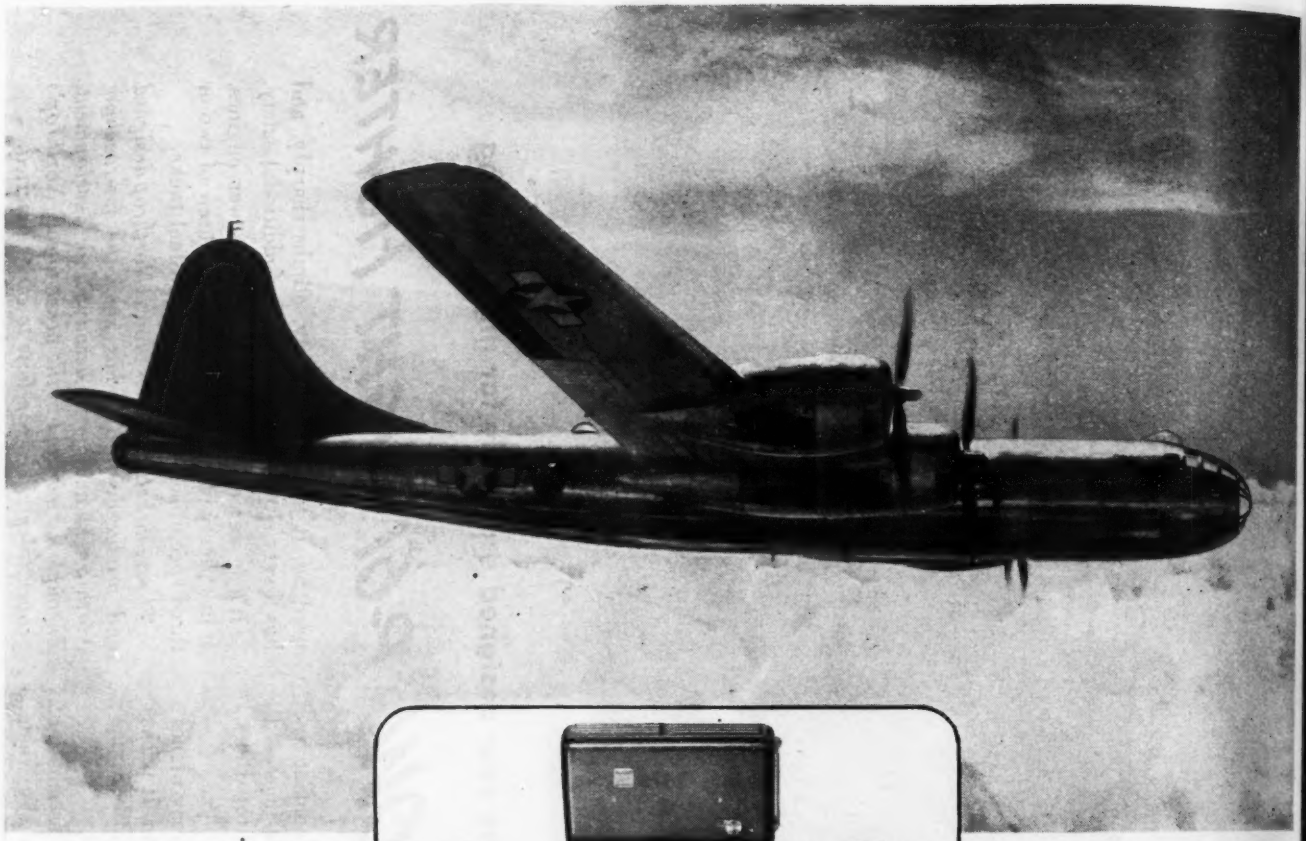
This revolutionary new fighter has a "combat urgency" designation. Our Army has now increased by 30% its original order for the Northrop Black Widow . . . the P-61 Night Fighter.

This deadly fighter stalks and finds enemy planes in pitch darkness as no other airplane can. It packs enough 20 millimeter cannons and .50 caliber guns to blast apart anything that flies.

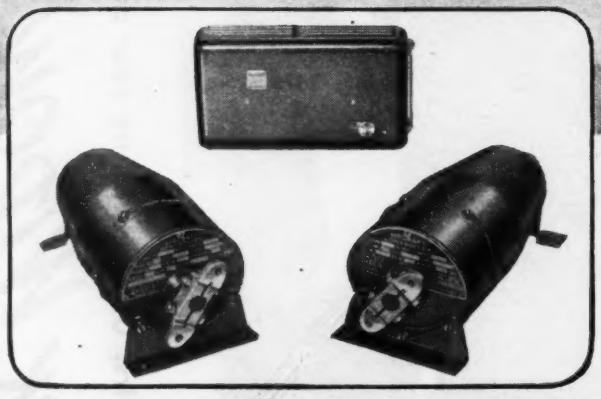
Big as it is, the Black Widow is fast as smaller fighters. Yet it can literally hover in the sky when need be. It takes off quickly, climbs sharply, and has a very slow landing speed for additional safety.

It's powered by twin 2000 horsepower engines. It has plenty of room for its fighting crew of two or three specialists—and long-range fuel tanks.

The remarkable Black Widow is Northrop designed and produced. Into it has gone the far-reaching Northrop know-how in aerodynamic development. Through the war and in the peace ahead, Northrop's proven talents will continue to serve America.



The Boeing B-29 "Superfortress" fastest of all heavy bombers, carries the greatest bomb load. Photo courtesy Boeing.



Barber-Colman control equipment used in the B-29. Two Control Motors and a Duplex Type Cabin Thermostat.

BARBER-COLMAN CONTROLS

FOR DUAL CABIN-HEATING SYSTEM IN THE "SUPERFORTRESS"

BARBER-COLMAN equipment serves on the famous B-29 "Superfortress" to keep temperature uniform in the pressurized cabin. There are two heating systems, one on each side of the heated space, delivering heated air from parallel duct systems. Air is supercharged before going to the heat exchangers, one of which is located in each wing. From each heat exchanger, the heated air goes to the duct system serving that side. Barber-Colman Control Equipment consists of a Duplex Cabin Type Thermostat simultaneously governing the position of two Control Motors on dampers which regulate the flow of warm air from the heat exchangers. By automatic *electric* control, damper positions are under constant adjustment to provide uniform cabin temperature and thus contribute materially to crew operating efficiency. The equipment functions rapidly and accurately to meet the fast-changing conditions encountered in flight. It is light, compact, and durable — specially designed for aircraft service. This and various other Barber-Colman Control Systems are available for many aircraft applications. Complete engineering data for your specific aircraft control application will be furnished on request.

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So you'll know what they can do, we will send a test wheel. Tell us material you'd like to finish and size wheel required.

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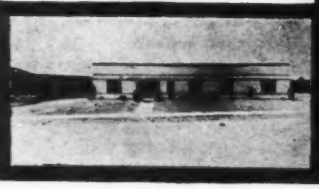

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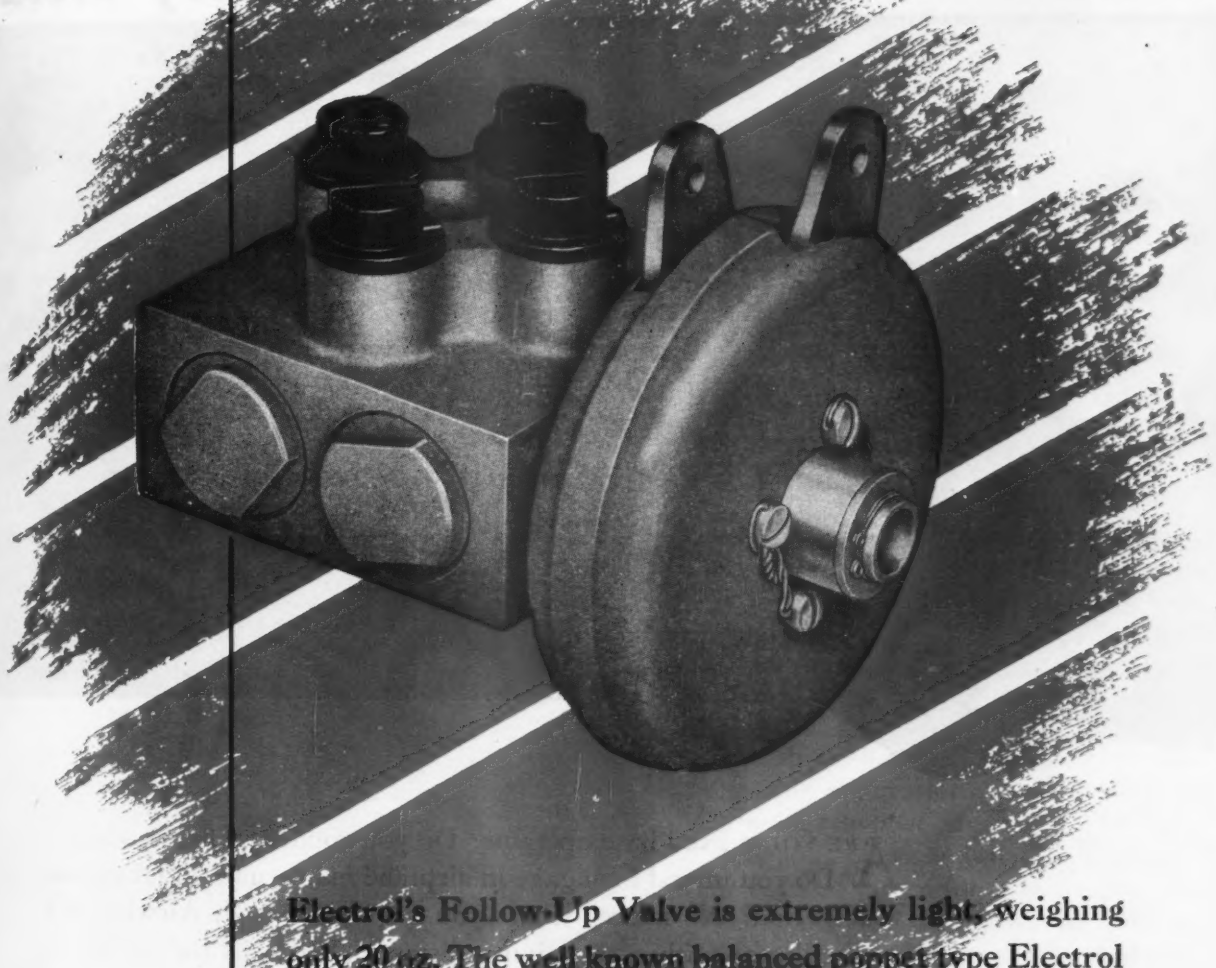
control



Electrol's Follow-Up Valve is extremely light, weighing only 20 oz. The well known balanced poppet type Electrol Selector Valve mechanism assures dependability.

ELECTROL'S FOLLOW-UP VALVE

Originally designed for Wing Flap installation, it is equally valuable to such other uses as carburetor, rudder or any service where smooth, accurate and complete control is required.

Electrol engineers will welcome an opportunity to design a Follow-Up Valve installation for any service in aircraft or general industrial application.

ELECTROL
HYDRAULICS

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ARE YOU a fixed base operator? Do you conduct a flying school? Do you intend to engage in airplane maintenance in the post-war period? No matter where you may be located, Airwing has a distributor within easy flying distance. Write us for the name of the one nearest you and make plans now to service your customers with high-strength, lightweight Airwing Fabrics and Tapes.

The Airwing line includes airplane and glider fabrics, balloon and special cloths. Airwing Tapes come in a complete selection—Grade A made from long staple Pima cotton, Lightweight and Utility—pinked edge, sealedge, biased, and pre-doped.

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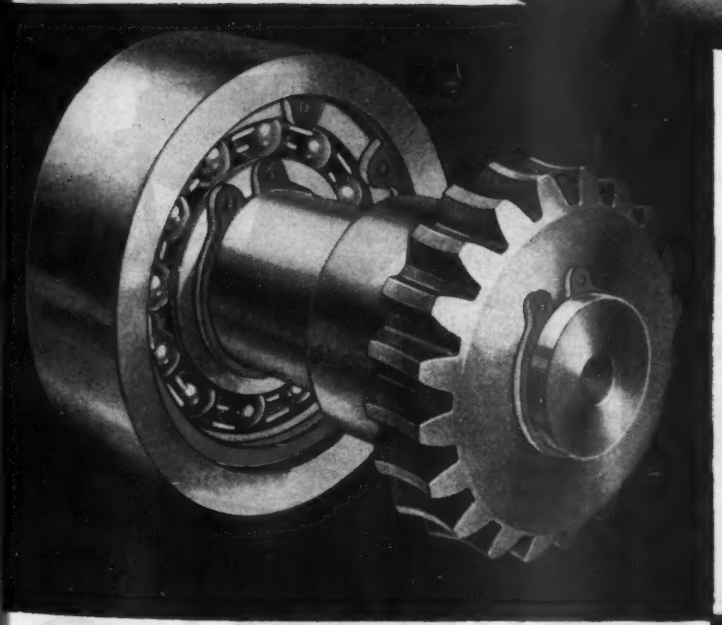


For thrust-load fixing, and shaft and housing applications, Waldes Truarc provides distinct advantages over nuts and bolts or wedges and washers . . . it reduces dimension and weight . . . saves material . . . cuts manufacturing time . . . simplifies assembly and dis-assembly.

On request, we will gladly furnish samples and full data for your tests.

● **Waldes Truarc presents a significant advance in retaining rings.**

It spreads or contracts without distortion; always retaining its perfectly fitting circular contour.

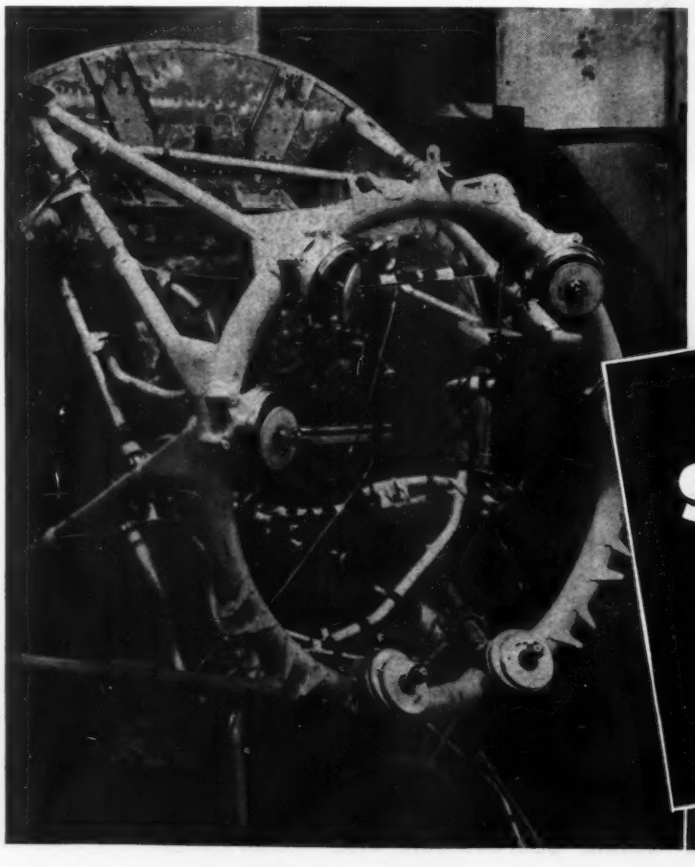
U. S. Pat. Re. 18.144
Sole Manufacturers in U. S. A.

WALDES KOH • I • NOOR • INC. ★ LONG ISLAND CITY, N. Y.

Canadian Representative: **PRENCO PROGRESS & ENGINEERING CORPORATION, LTD.,** *72-74 Stafford St., Toronto*

OVER THE "HUMP" TO

Engine mount for Curtis Commando made of SHELBY Seamless Aircraft Tubing. Pound for pound it is the strongest type of construction known.



SHELBY SEAMLESS *Aircraft Tubing*

WALLS WITHOUT WELDS

CHINA with the COMMANDOS

Seamless steel tubing pulls them up and sets them down

THE big Commandos that fly over the "Hump" to China are making history. In spite of "impossible" difficulties and enemy attacks these huge planes are keeping open the last supply line. They are freighting millions of pounds of war material into hard-pressed China through the 20,000 foot peaks of the ice-clad Himalayas. Jeeps, light artillery, spare engines, gasoline drums, ammunition and other material are being lugged over the mountains and then landed on the small, hazardous fields of China. Such service puts a terrific strain on the vital parts of the ship.

The engine mounts in particular must be absolutely dependable. There are no emergency landing fields in the Himalayas. The seamless tubes and the ring that hold the powerful engines in place are SHELBY Seamless Aircraft Tubing—the finest obtainable. These engine mounts have high resistance to vibration and fatigue and have proved so satisfactory in service that the basic design has remained practically the same since the start of the war.

When the Commandos sit down at the end of the flight, the success of the whole trip depends on the ability of the landing gear to absorb the shock of the heavily-loaded ship. Here again, SHELBY Seamless Steel Tubes are used for the tough jobs and can be depended upon to take the punishment of rough fields.

Much of the tubing for the Commandos, Flying Fortresses, Liberators and dozens of other planes is furnished by National Tube Company. No matter what type of aircraft tubing you need, National's Complete Aircraft Tube Service can furnish it.

Landing gear on the C-46 Commando. Seamless steel tubing plays an important part in bracing and taking the thrust of the main oleo strut.

NATIONAL TUBE COMPANY

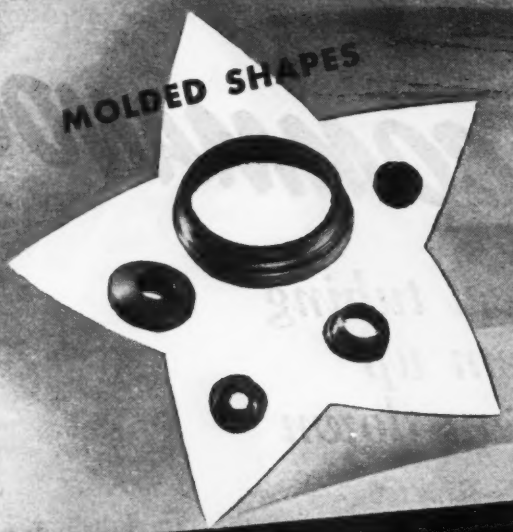
PITTSBURGH, PA.

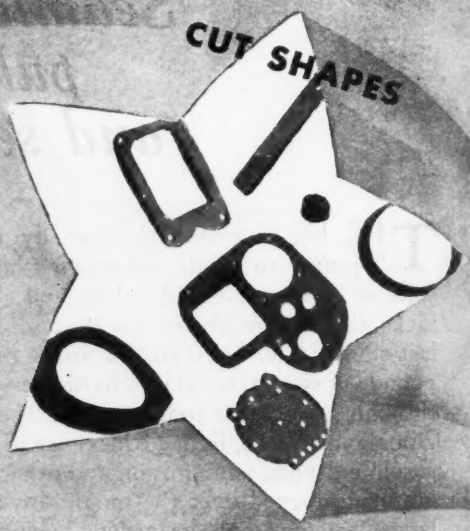
Columbia Steel Company, *Pacific Coast Distributors*

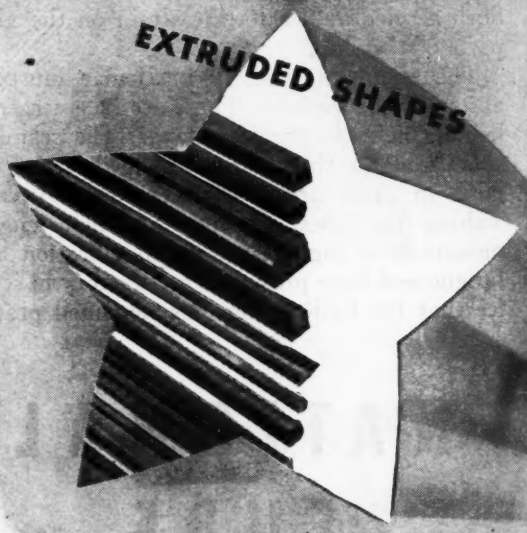
United States Steel Export Company, New York

UNITED STATES STEEL

Stars on the Postwar Stage–







TO PERFORM FOR *Your Products*

ACADIA SYNTHETIC PRODUCTS

From their performance in wartime goods, Acadia Synthetic Products have assured themselves a place in products of peace.

Processing synthetic rubber to give it form, Acadia Synthetic Products molds, extrudes and cuts it to exacting tolerances to meet your requirements.

Acadia Engineers are prepared to help you obtain the characteristic or combination of characteristics you require. Feel free to call upon them at any time with any problem involving the possible use of Acadia Synthetics.

DIVISION OF WESTERN FELT WORKS

ACADIA *Synthetic* **PRODUCTS**

Processors of Synthetic Rubber and Plastics • Sheets • Extrusions Molded Parts

DIVISION WESTERN FELT WORKS

Largest Independent Manufacturers and Cutters of Felt

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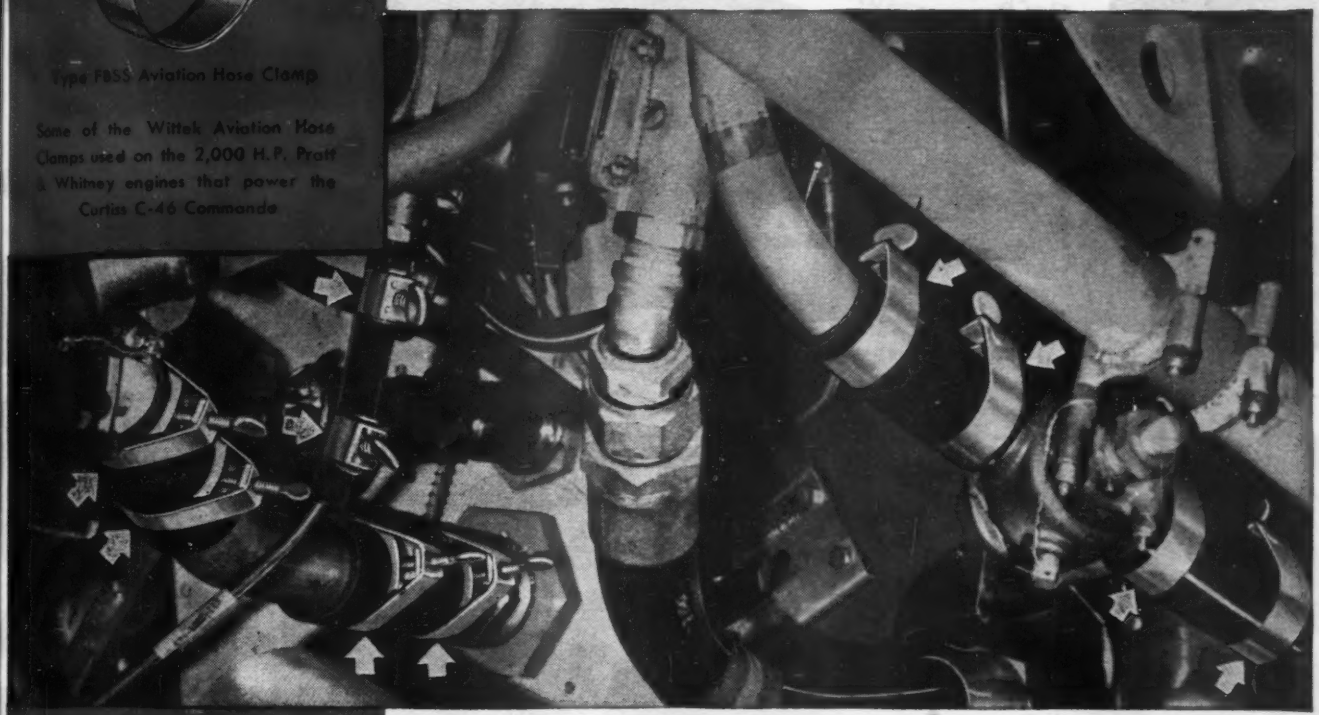
Type FBSS Aviation Hose Clamp

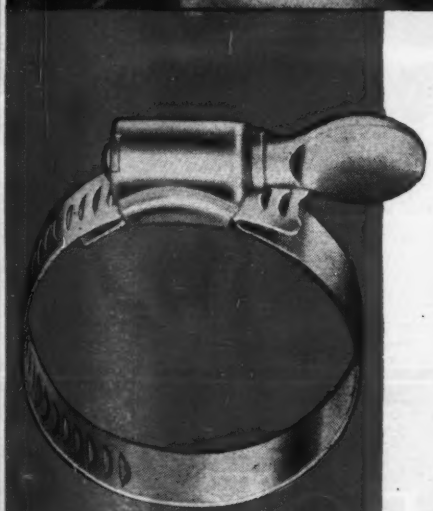
Some of the Wittek Aviation Hose Clamps used on the 2,000 H.P. Pratt & Whitney engines that power the Curtiss C-46 Commando

Standard in the Aviation Industry

WITTEK

Aviation Hose Clamps





Type WWD Worm Drive Aviation Hose Clamp

Wittek now offers two distinctly different aviation hose clamps complying with the requirements of specification AN-FF-C-406A.

Type FBSS—is manufactured in the standard AN-748 sizes and incorporate a bridge extender which provides uniform sealing characteristics. This is the most effective type hose clamp for all applications in which an adjustable clamp is not necessary.

Type WWD—a worm drive stainless steel hose clamp which, because of its wide range of adjustment, is the most effective clamp for uses where a clamp capable of accommodating various diameters of hose is necessary.

These two Wittek Aviation Hose Clamps are made from stainless steel, and combine the superior physical qualities of that material with the well-known Wittek qualities of superior service and high dependability. There is a Wittek Hose Clamp to meet every requirement of the Aviation Industry. Write for new descriptive catalog.

War Bonds for Victory

ARMY E NAVY

Buy MORE than ever before

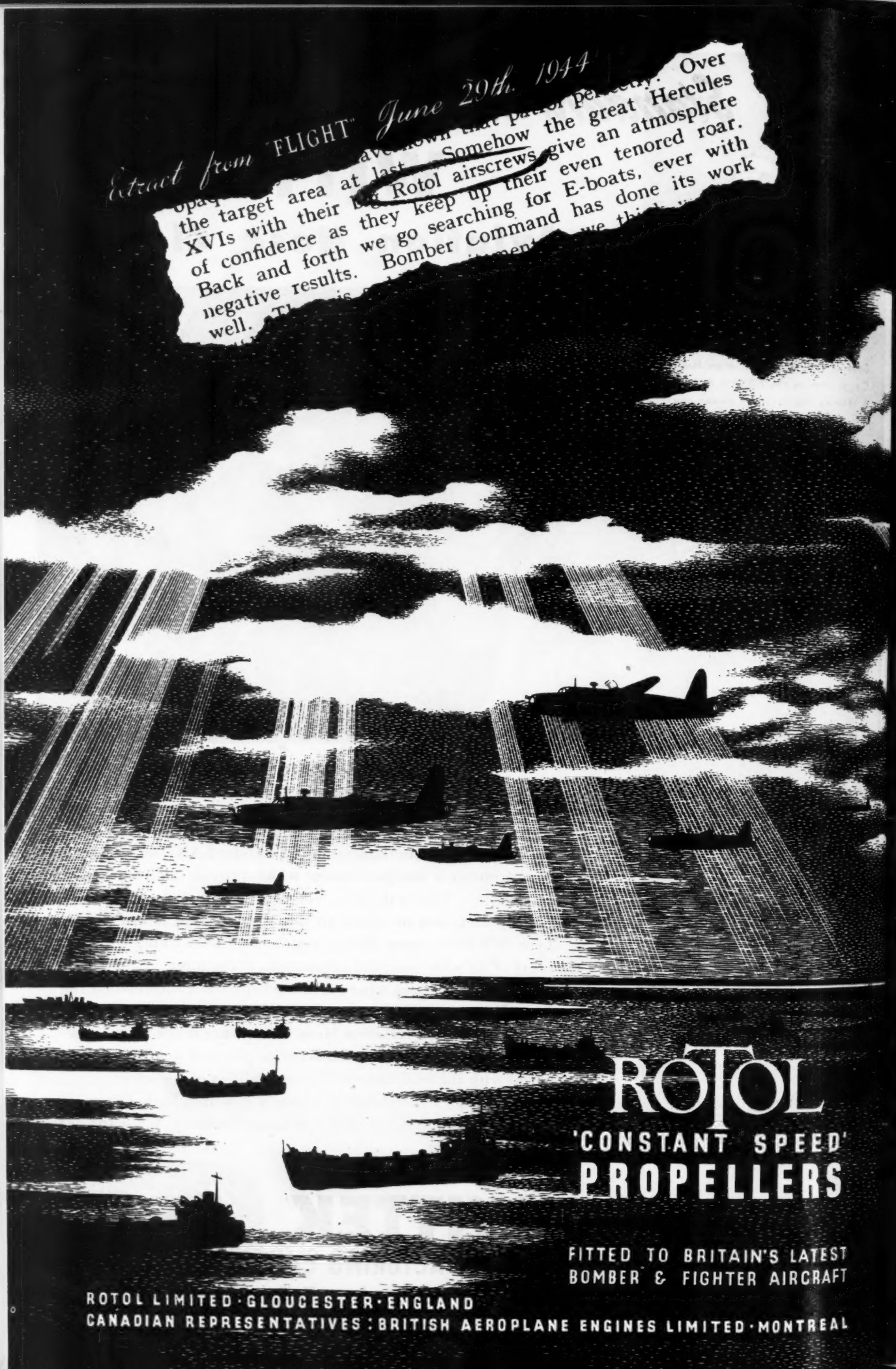
WITTEK

MANUFACTURING CO.

4305-15 West 24th Place, Chicago 23, Ill.

Aviation HOSE CLAMPS

WM Co.


Extract from "FLIGHT" June 29th. 1944
the target area at last. Somehow the great Hercules
XVIs with their Rotol airscrews give an atmosphere
of confidence as they keep up their even tenored roar.
Back and forth we go searching for E-boats, ever with
negative results. Bomber Command has done its work
well.

ROTOL

'CONSTANT SPEED' PROPELLERS

FITTED TO BRITAIN'S LATEST BOMBER & FIGHTER AIRCRAFT

ROTOL LIMITED · GLOUCESTER · ENGLAND

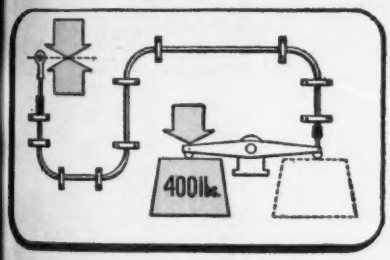
CANADIAN REPRESENTATIVES: BRITISH AEROPLANE ENGINES LIMITED · MONTREAL

Dependable *all around duty assured with* Simmonds Push-Pull Controls

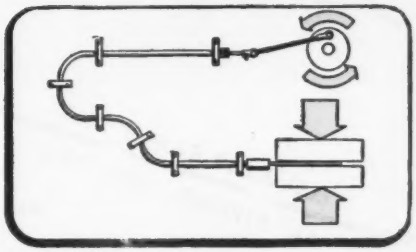
Read how these other tests, conducted to AAF specifications, show how Simmonds products more than qualify for EXTRA DUTY as well as NORMAL DUTY operations.

FIRST TO CARRY THE YELLOW DOT

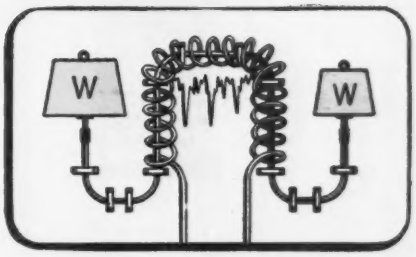
of Army Air Force Winterization acceptance for operation in extreme temperatures is the Simmonds-Corsey Push-Pull Control. Comprehensive tests with temperatures as low as minus 72°F. and as high as 160°F. prove efficient operation under wide variety of conditions.



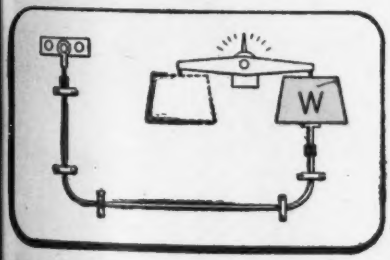
STATIC STRENGTH: *In this test Simmonds push-pull control successfully withstands tensile and compressive forces of 400 lbs. Credit simplification of design, improved linkage.*



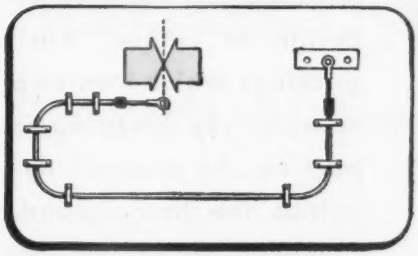
ENDURANCE: *Cycled 30,000 times under stress, as illustrated, Simmonds controls are not affected in any way, and can be expected to outlast the life of unit served.*



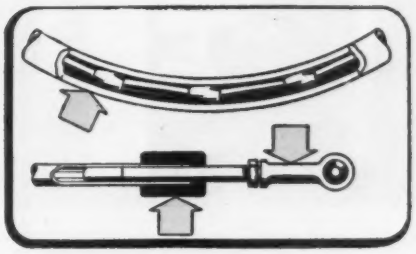
EFFICIENCY: *Input-output ratio of control is measured at various temperatures in insulated chamber. Result: average efficiencies are twice the AAF requirements.*



PRECISION CONTROL: *Motion between tension and compression is negligible. Before endurance test: average—.046"; after—.082". Simmonds are precision-built controls.*



DEFORMATION: *AAF specifications call for loads ranging from 10 to 50 lbs. Allowable average deformation is .140". Simmonds controls average only .083".*



CORROSION: *Simmonds controls meet AAF specifications for corrosion resistance with standard cadmium plated or anodized surfaces. Tube ends are rubber sealed.*

INQUIRIES concerning War Contracts or Post-War problems involving push-pull control equipment are invited. Our service engineers will furnish you gladly with analyses and recommendations. Telephone or write to your nearest Simmonds office.

SIMMONDS EQUIPMENT FLIES WITH EVERY TYPE OF ALLIED AIRCRAFT

Automatic Engine Controls — Push-Pull Controls — Spark Plugs
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VITAL HYDRAULIC POWER ...EFFECTIVELY SEALED IN... BY LINEAR "PAR" PACKINGS

In delivering hydraulic energy from its source to the point of application it is necessary to maintain a fluid tight seal throughout the operating cycle.

This Birdsboro Steam Platen press employing water as a pressure medium, uses "Par" packings to insure trouble free, leak proof performance.

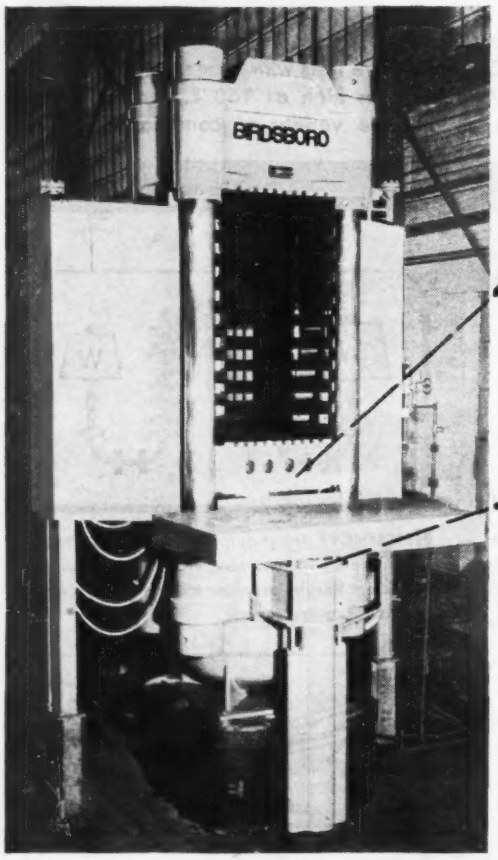
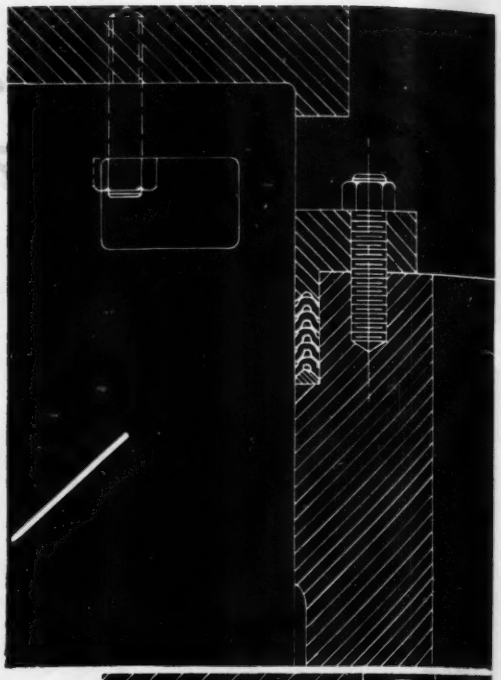
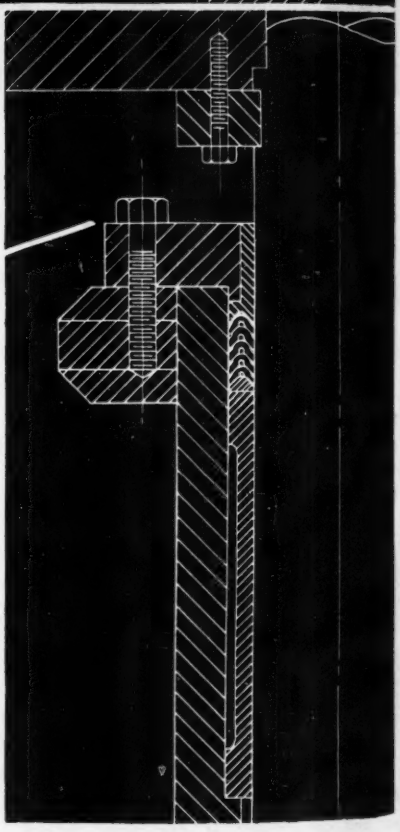


Photo and sketches courtesy Birdsboro Steel Foundry and Machine Company, Birdsboro, Pa.





The attention of hydraulic equipment designers is called to the *distinctive design* of Linear "Par" packings which insures a *completely automatic packing*. As pressure develops the lips expand, and expansion is proportionately reduced when pressure is lowered, insuring maximum efficiency and uniform pressure maintenance, also eliminating extreme friction and wear.

Remember, Linear "Par" packings are manufactured from *six compositions*, each for a specific service. They are the choice of design engineers for hydraulic equipment of the most modern type. The consultation of Linear engineers is available . . . sample rings upon request.

LINEAR
PACKING & RUBBER CO.
STATE ROAD & LEVICK STREET
TACONY, PHILADELPHIA 35, PENNA.

Get

FULL FIRE PROTECTION

within a "Small Airport" Budget

Hitched to the back of a small car, a jeep or a light truck, the Kidde Trailer unit can be whizzed to a crash in a few seconds...all ready for action.

Equipped with a six-unit battery—having a total capacity of 300 lbs. of fire-choking carbon dioxide gas—plus four portable Kidde extinguishers, a hose reel and a nozzle, the Kidde fire-fighting Trailer is a two-wheeled fire department packing a terrific wallop. Furthermore, its low cost will fit the budget of even the smallest post-war airport.

So, if you are planning to build a new airport, or intend modernizing, and you want *full* fire protection at low cost, you will want to know more about the new Kidde Trailer. Write for detailed information today.

Walter Kidde & Company, Inc. • 140 Cedar Street • New York 6, N. Y.

Whether 1945 is Really War's End Or We're Still Fighting Away

UNITED STATES ELECTRICAL TOOLS ARE BUSY ON ALL PRODUCTION FRONTS

EVEN the seventh son of a seventh son can't tell you . . . but we can all hope, can't we? One thing we can promise you though, UNITED STATES ELECTRICAL TOOLS for 1945 will carry on with the same vim and vigor which have enabled users to lean on them for biggest production at lowest cost for many decades. It's a pledge!

SPECIAL 1/4" HEAVY-DUTY AVIATION DRILLS

MODEL 14 ARS
Net weight 3¾ lbs.

MODEL 14 ARD
Net weight 4¾ lbs.

Small but mighty, ball bearing throughout. Quick make and break switch, with locking pin in center of trigger.

WRITE TODAY FOR DETAILS REGARDING DELIVERIES AND OTHER INFORMATION

THE United States ELECTRICAL TOOL CO.
CINCINNATI 14, OHIO

UP... UP... UP into the sky!

DOWN... DOWN... DOWN to the ground again... just like the ride you take on your office elevator. That's the job Federal Aerial Navigation Equipment is doing in controlling air-traffic.

Federal traffic control equipment guides the plane from the minute it leaves the runway, right into the skies, heads it fast and sure for its destination and guides it back to earth... all with speed and accuracy.

And looking forward to the greater amount of passenger and freight traffic that will take to the air tomorrow, Federal has developed even better sky traffic control equipment.

Here in one compact research and manufacturing organization is centered the know-how to design and manufacture complete air-traffic control systems for every need. Now is the time to have Federal help you plan for the air age of the future.

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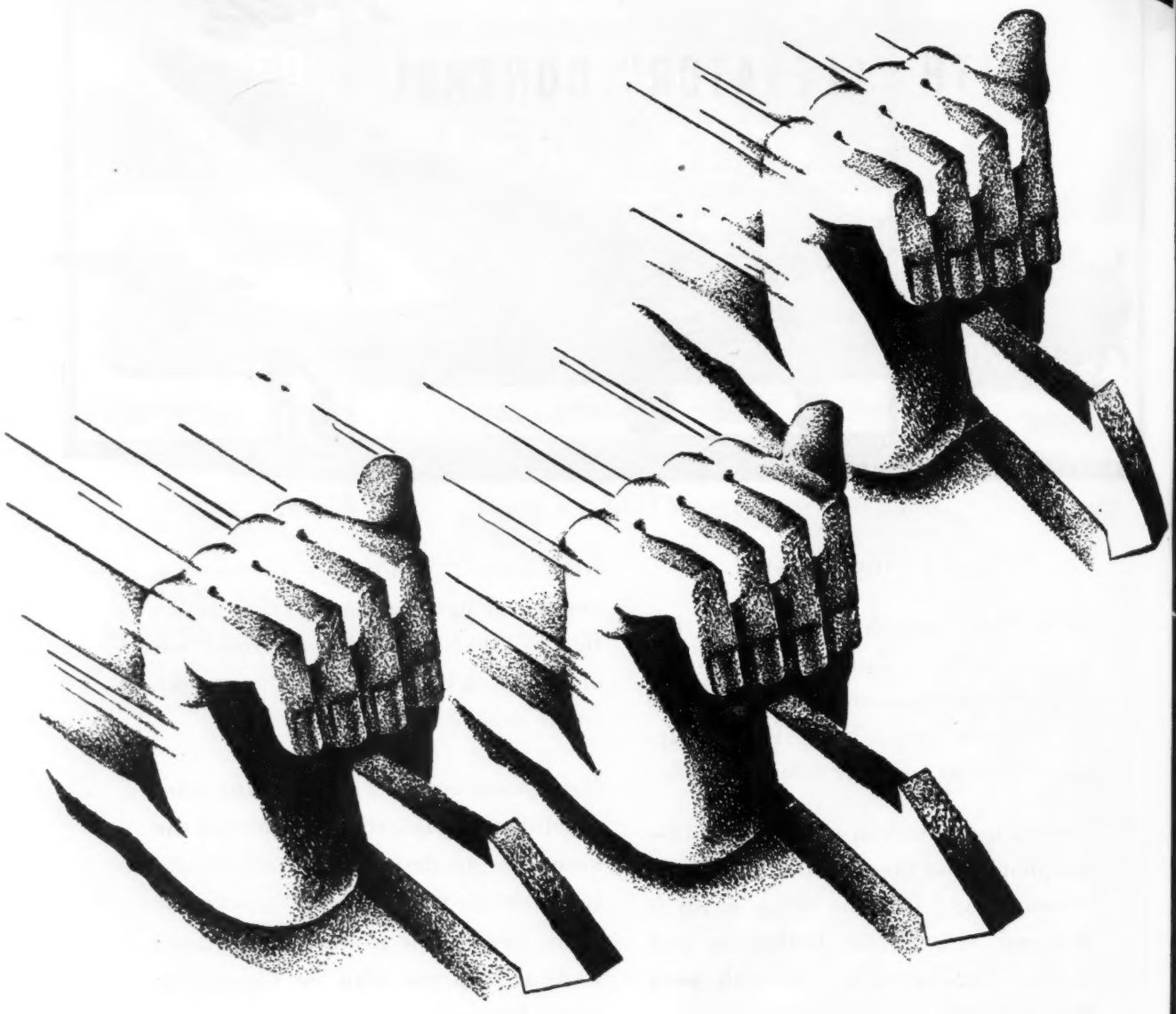
THREE NEW PARTNERS . . . GOING



TERMINAL TOWER
CLEVELAND, OHIO

AHEAD WITH DRESSER

DRESSER INDUSTRIES now number ten.

Formerly, we were seven companies helping to bring basic services to the user more efficiently.

Our three new partners, each a specialist in its fields, both round out and broaden Dresser's scope of usefulness. This larger Dresser group can now serve industry and consumers with more products and greater experience.

The new Dresser members are bulwarked by an organization that assures their customers continued progress in product improvement, greater wherewithal for pioneering research and steady maintenance of service.

Dresser Industries, Inc., has progressed through the management principle of giving to alert, independent know-how an adequate backing and pooled resources. From these, each member draws teamed strength far greater than it could enjoy alone. The three new members of Dresser Industries, Inc., increase opportunities for mutual aid among the teammates, and at the same time, draw from the group advantages for those they serve.

MEMBER COMPANIES

Dresser Manufacturing Division
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The Bryant Heater Co.
Cleveland, Ohio

Clark Bros. Co., Inc.
Olean, N. Y.

Pacific Pumps, Inc.
Huntington Park, Calif.

Bovaird & Seyfang Mfg. Co.
Bradford, Pa.

Dresser Mfg. Co., Ltd.
Toronto, Ont.

Van der Horst Corp. of America
Olean, N. Y. Cleveland, Ohio

PLUS

*International Derrick & Equipment Co.
Columbus and Marietta, Ohio
Torrance, Calif. Beaumont, Texas

*Roots-Connersville Blower Corp.
Connersville, Ind.

*Stacey Bros. Gas. Construction Co.
Cincinnati, Ohio

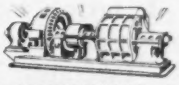
DRESSER Pipe couplings and repair devices for pipeline systems. Rings and forgings.

BRYANT Gas-fired boilers, winter air conditioners, furnaces, unit heaters and conversion burners for residential, commercial and industrial heating.

CLARK Engines and compressors for oil production and refining. Marine and stationary Diesel engines.

PACIFIC Hot-oil charging pumps; boiler-feed pumps; general-service pumps for the petroleum and other industries; oilwell plunger pumps; deep-well turbine pumps.

INTERNATIONAL DERRICK Oilwell pumping units, derricks and masts, drawworks, rotary tables and drilling units. Airport, communications and electric-power-line equipment and prefabricated steel buildings.



ROOTS-CONNERSVILLE Positive displacement and centrifugal blowers, exhausters, boosters and compressors. Air and liquid pumps and meters.

STACEY BROS. Storage holders, tanks and pressure vessels for the gas, oil, chemical and food industries.

BOVAIRD & SEYFANG Pumping engines, jacks, "powers", storage tanks and allied supplies and equipment for oilfields.

VAN DER HORST PORUS-KROME—a patented process of applying chromium lining on cylinder walls, piston rings and crankshafts—for longer wear.

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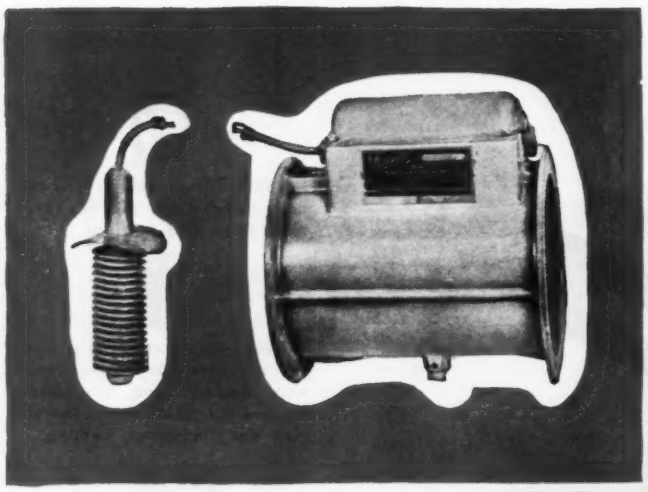


No. 707 Sylphon Temperature Regulator. This instrument comprises a thermostatically controlled valve, which proportions the mixture of hot and cold air admitted to the heater ducts—to maintain a constant temperature in the flight deck and bombardier's compartment.

CONTROLLED WARMTH FOR THE "OFFICE"

FIVE YEARS AGO the first B-24 was slowly taking shape in the San Diego plant of Consolidated Vultee . . . and now the V-Grand —Liberator No. 5000, complete with thousands of autographs, has joined its predecessors to speed victory.

One of the many automatic devices that add to the comfort and efficiency of B-24 crews is a Sylphon Aircraft Temperature Regulator. It automatically proportions the mixture of hot and cold air to maintain a constant, comfortable temperature in the bombardier's compartment and control room (known familiarly by airmen as the "office").

This Sylphon instrument is but one of many successful applications of time-proven Sylphon Bellows to aircraft design. Their post-war uses will be universal in the temperature and pressure control fields.

A fully staffed engineering consultant service is available at all times without obligation to users or prospective users of Sylphon Bellows and Bellows Assemblies.

, , ,

Inquiries are invited, both for post-war and immediate delivery. Bulletin **AA-822** describes many typical Fulton Sylphon applications in the aircraft field.

A new movie film—"The Story of Metal Bellows"—is available to interested executives and organizations.

ARMY E NAVY

FULTON SYLPHON

TEMPERATURE CONTROLS

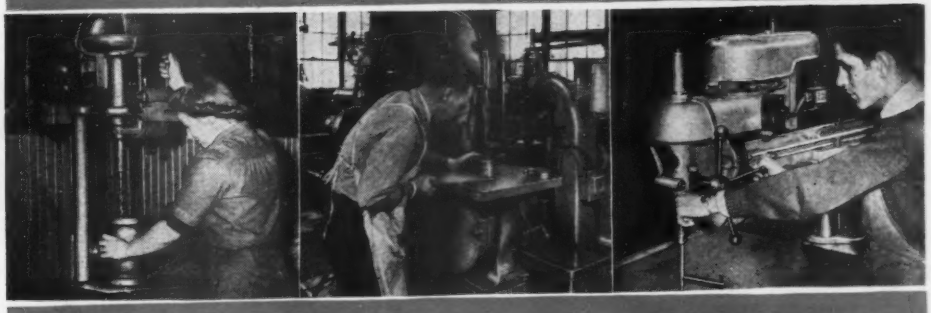
BELLOWS . . . BELLOWS ASSEMBLIES

THE FULTON SYLPHON CO., KNOXVILLE 4, TENNESSEE

Canadian Representatives, Darling Brothers, Montreal

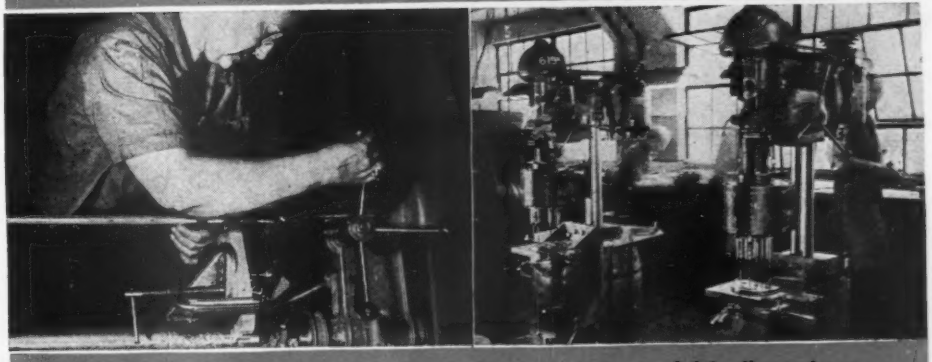
DON'T LET PRE-WAR METHODS KILL POST-WAR PROSPERITY!

HERE'S HOW WALKER-TURNER MACHINE-TOOLS CUT COSTS!



260-5200 R.P.M. 60-5300 S.F.M. 160-8300 R.P.M.

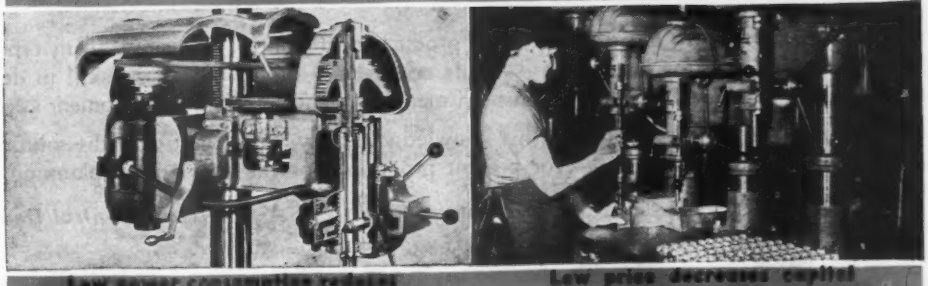
Wide range of operating speeds enables you to select the optimum cutting speed for any material.



Walker-Turner flexibility saves time and cuts costs in special tooling set-ups.

Set up horizontally, this Walker-Turner 15" Drill Press flares the ends of tubing.

This Walker-Turner 20" Drill Press drills five holes and reams two holes in one operation.



Low power consumption reduces operating costs.

This motor on a Walker-Turner 20" Drill Press provides speeds for drilling up to ¾" in steel, 1" in cast iron.

Low price decreases capital investment.

This Walker-Turner 4-spindle 20" Drill Press costs no more than a single heavy unit, yet has several times its production capacity.

The war years have proven to American Industry that the light machine tool has an important place in Production. Walker-Turner machine tools have demonstrated their ruggedness under most exacting conditions.

Don't let pre-war operating methods affect your post-war competitive position. The versatility of Walker-Turner machine tools will ensure production equal to—and, in many cases, better than—heavier and more expensive equipment.

WALKER-TURNER COMPANY, Inc.
Plainfield New Jersey

walker-Turner COMPANY, Inc. PLAINFIELD, N.J. U.S.A.

MACHINE TOOLS

DRILL PRESSES — HAND AND POWER FEED • RADIAL DRILLS
METAL-CUTTING BAND SAWS • POLISHING LATHES • FLEXIBLE SHAFT MACHINES
RADIAL CUT-OFF MACHINES FOR METAL • MOTORS • BELT & DISC SURFACERS

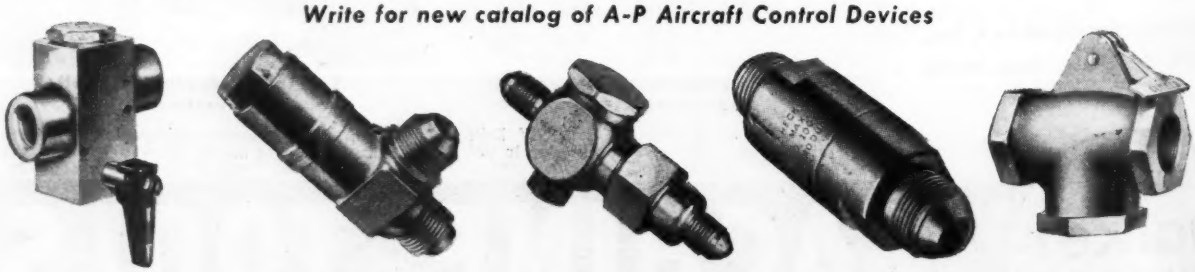
AIRCRAFT CONTROL DEVICES

... Built to HIGH-PRECISION Standards

From long experience in the production of Control Devices of many types, A-P offers the aircraft industry the benefits of — wide research — highly developed skill in designing and engineering — unequalled facilities in both manpower and production equipment keyed to precision products.

We invite you to use this knowledge, ability, and facilities in the solution of your more intricate control problems — for present production or for your future planning.

Write for new catalog of A-P Aircraft Control Devices



HYDRAULIC KWIKLOZ VALVES

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DOES AN AERONCA DEALER MAKE?

Facts and Figures Point to YOUR Opportunity to DO BIG BUSINESS WITH A SMALL AIRPORT

You can make a career for yourself—become a leader in your community—with a small airport operated under the Aeronca plan! Scores of other Aeronca dealers have done it—and you can, too, if you have the stuff! Let Aeronca show you how.

THE AERONCA CREED

"We will show young people how to get started in the Aviation business, and go as far as their energies and abilities will take them!"

That's right! Aeronca will show you *how*, but as an Aeronca dealer, *you run your own show!* Ask for details.

O. E. DICKERHOOF, Chanute, Kansas reports: "... from then on sales increased until in 1941. I sold 84 Aeroncas in one year."

E. A. ELLISON, Cleveland, Ohio, writes that: "Our Aeronca franchise proved to be the most profitable phase of our aviation activities."

HAROLD R. SCHESSELMAN, Mankato, Minn. says: "The sale of Aeroncas in pre-War days produced my operation's greatest revenue."

JOHN E. SCHWANER, Portola, California, says: "Before the War we sold over 40 new Aeroncas, resulting in a highly successful year."

LYMAN S. COX, Jr., Owensboro, Kentucky: "Became dealer in 1938 with one Aeronca. Now have 2 airports and 35 airplanes."

E. G. YOUNGS, Huron, South Dakota: "During year prior to War our net profit from sale of Aeroncas was nearly $10,000."

Get The Facts Now! Send, right now, for Aeronca's valuable books showing how *you* can do Big Business With A Small Airport. Learn for yourself just how far Aeronca actually will go with you to make *your* airport a *year 'round paying business!* Fill out and mail coupon today.

AMERICA'S PERSONAL PLANE
AERONCA
AIRCRAFT CORPORATION
MIDDLETOWN, OHIO

Al Bennett, Director of Sales
Aeronca Aircraft Corp.,
Middletown, Ohio.

Please send me the valuable Aeronca booklets checked below. I enclose 10c for each one ordered.

☐ "MAKING SMALL AIRPORTS PAY WITH AERONCA"
☐ "WHY YOU SHOULD BE AN AERONCA DEALER"

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City_____ State_____ H-1

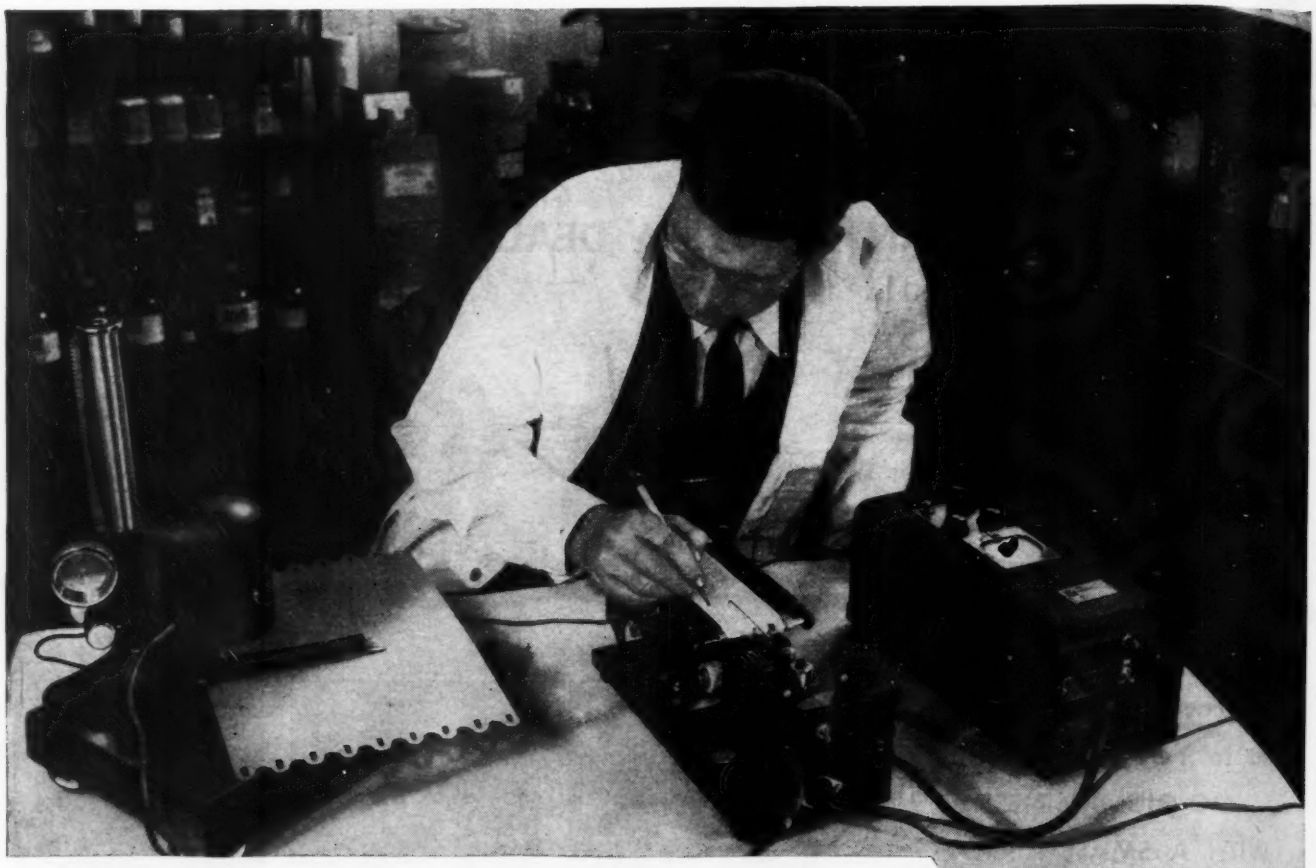

Photo courtesy of Addressograph-Multigraph Corporation

High Priorities...

BOUGHT THIS BRUSH SURFACE ANALYZER

When the Addressograph-Multigraph Corporation in Cleveland, found it necessary to accurately measure the surface finish on grained zinc plates, they bought a Brush Surface Analyzer to do the job. Now, they are able to control these surfaces to micro-inch roughness by studying graphic readings of the irregularities measured to one millionth of an inch (.000001").

This instrument was purchased with a high priority rating. No longer is this necessary. Greatly expanded production facilities are now enabling us to make *prompt delivery* with *no priorities.*

The Brush Surface Analyzer is an indispensable tool in modern production where closer control of surface finish is greatly emphasized.

See how this instrument can best serve your production needs by a demonstration at your plant.

Also write for a free brochure—"Surface Finish—.000001 inch."

THE BRUSH DEVELOPMENT COMPANY

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7 REASONS WHY

Your best bet for AC Welding is a "Bumblebee"

with a Stinger that Penetrates

Every feature of design and construction, both inside and outside the sturdy case of the Wilson "Bumblebee", has been planned to give the utmost in efficient, dependable and economical service:

- *Precise, Stepless Adjustment of Welding Current* to any value within NEMA range, provided by easy-turning crank.
- *Efficient Ventilation* by motor-driven fan assures safe, dependable operation, even when welding with maximum current.
- *Reduced Power Factor Charges* and relief for overloaded power lines is provided by built-in capacitors.
- *Coils Protected Against Fire and Vermin* by mica and glass fabric insulation.
- *Interchangeable Primary Terminals* permit easy, rapid change from low to high line voltage or vice versa.
- *Output or Secondary Terminals Readily Accessible* by removing 4 screws which hold small insulating panel.
- *High Visibility of Current Indicator* is assured by large, easily read calibrated scale located outside case.

These features are incorporated in every "Bumblebee" welder—either regular or all-weather model. "Bumblebee" welders are also performing a valuable service as a power source for automatic welding heads.

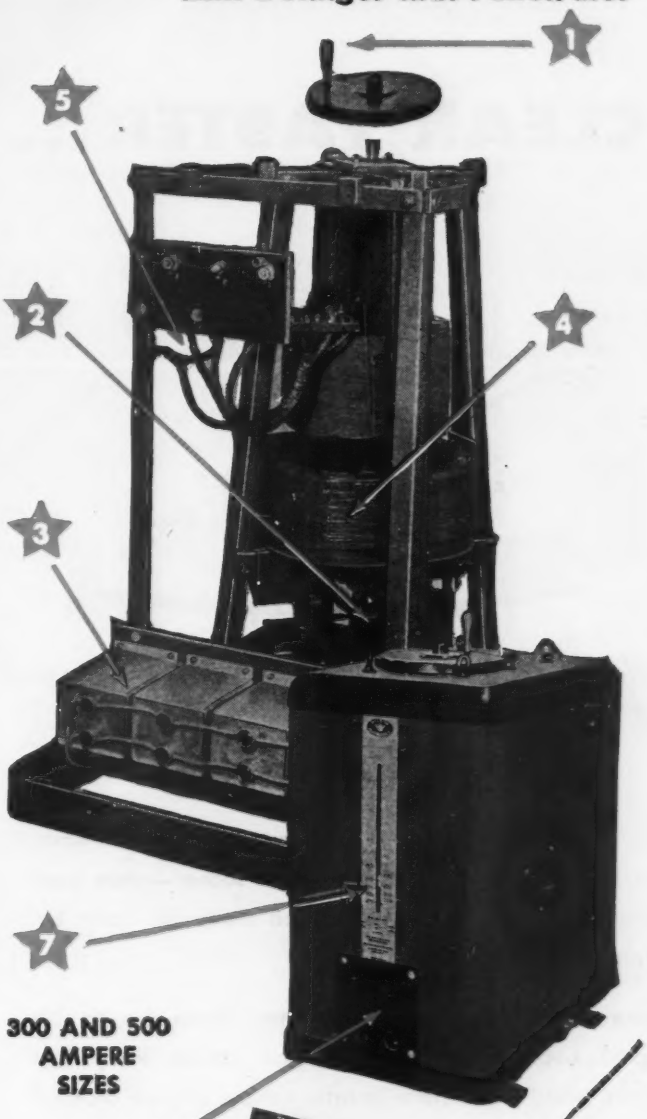
In addition, the "Bumblebee" offers all the advantages of AC welding:

- —Low Maintenance because of absence of moving parts
- —Low Power Costs because of high electrical efficiency
- —Faster Welding due to absence of arc blow and use of larger electrodes
- —Improved Quality of Welds

—at no greater first cost than other types of welding equipment.

Other AC welders in 100, 200, 750, 1000 ampere sizes.

Mail the coupon today for new catalog—or write to your nearest Airco office.



300 AND 500 AMPERE SIZES

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Please send copy of your new "Bumblebee" Catalog to

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Firm.....

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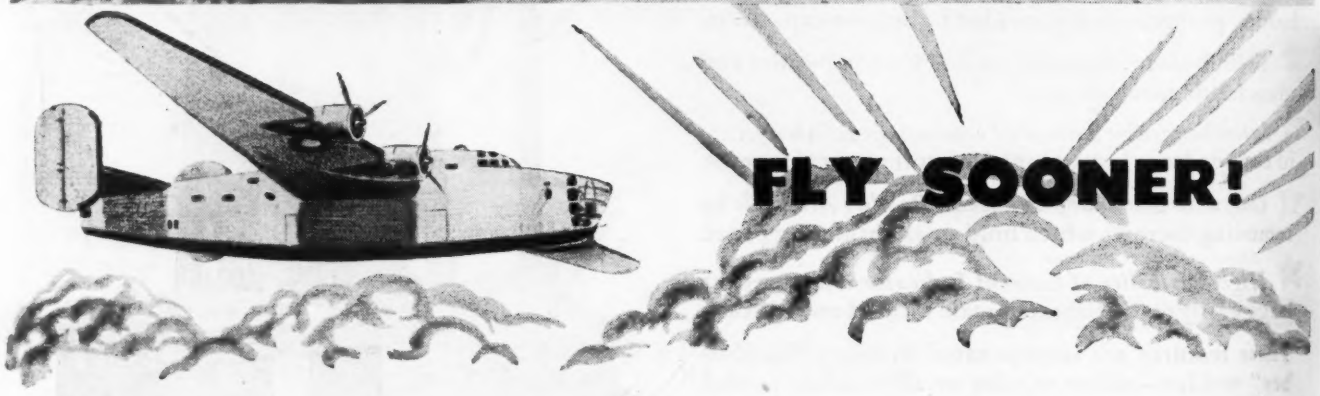
City..... State.....



Your field makes a faster "comeback" after the worst blizzard—planes are in the air much sooner—when your runways are kept free of snow and ready for action by Walter Snow Fighters.

These specialized units remove snow faster (up to 30 m.p.h.) because unmatched traction utilizes every last horsepower. They clear a greater volume of snow on each run (up to a 28 ft. width) because they are designed to mount the biggest, most efficient plowing equipment. Sustained high-speed plowing throws snow far to the side, eliminating dangerous snow banks.

The exclusive Walter Four-Point Positive Drive provides this outstanding performance. Automatic locking differentials proportion power to FOUR driving wheels according to their traction at any instant. Even if only one wheel maintains traction, Walter Snow Fighters move steadily ahead—without the wheel-spinning, side-slipping and stalling that slow down or stop conventional trucks.

Give your airport this fast, unfailing protection. Write today for complete literature on Walter Snow Fighters.

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WALTER
SNOW FIGHTERS

"Some Trolley Ride those springs take!"

A MUCH-IMPRESSED visitor to the Muehlhausen hot-coiling plant made this comment after inspecting the enameling and baking "station" shown below—the "end of the line" for thousands of springs each day.

This mechanized process is typical of the streamlined set-up in the Muehlhausen hot-coil plant, which is devoted entirely to producing large springs.

Specialized equipment, such as *automatic* hot-coiling machines, *block-long* heat-treating lines, *precision* grinding facilities, all on a smooth running production-line basis, assures Muehlhausen customers of quick delivery on large springs of *any design,* in *any quantity,* and to *split-hair tolerances.*

Check with Muehlhausen on your large spring problem—your production schedule and product both will benefit!

MUEHLHAUSEN SPRING CORPORATION

Division of Standard Steel Spring Company

740 MICHIGAN AVENUE • LOGANSPORT, INDIANA

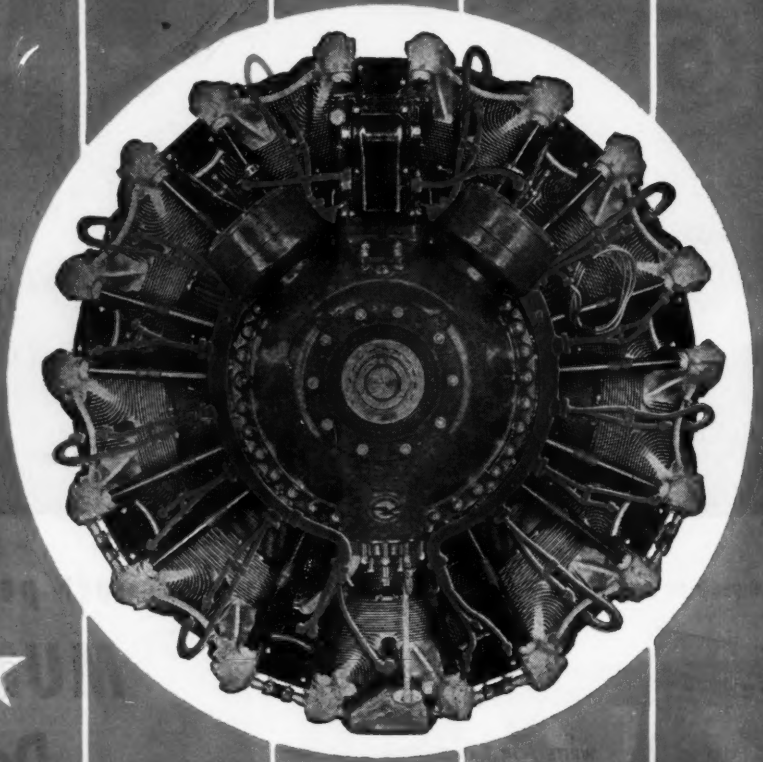
WRITE FOR LARGE SPRING FOLDER!
Showing the extensive facilities at Muehlhausen for making large springs.

To improve product performance, use

MUEHLHAUSEN Designed SPRINGS

Bolton

RADIO SHIELDED IGNITION ASSEMBLIES
OF DEPENDABILITY



BOLTON MANUFACTURING CORP. -- WEST HAVEN, CONN.

Fuel Tanks of Navy "Coronado" Patrol Bombers

Sealed with PRESSTITE SEALING COMPOUNDS

Many a tale has been told of the great work being accomplished by the Navy's PB2Y's—known as "Coronado" Patrol Bombers—in jobs ranging from bombing missions to heroic surface rescues. The fuel tanks of the Navy transport version of this type of plane, designated PB2Y-3R, are resealed by the Rohr Aircraft Corp. of Chula Vista, California.

Integral Fuel Tanks in these giant ships, the largest mass-produced plane in Navy service, are sealed with Presstite sealing materials using the Rohr Tank Seal Process. This method of sealing integral tanks, developed by Rohr Aircraft Corp., using these proven Presstite materials, represents the latest development in sealing tanks in large transport, cargo, and similar type planes.

Meeting the complex sealing requirements of the aircraft industry is only one example of Presstite's ability to originate and develop sealing compounds for specific requirements.

If your product or your manufacturing processes call for sealing or coating compounds, send your requirements to sealing specialists. We'll gladly work with you and your engineers in suggesting the most effective compounds to fit your needs.

PRESSTITE SEALING COMPOUNDS

PRESSTITE ENGINEERING COMPANY, 3910 Cheuteau Avenue, St. Louis 10, Missouri

A Partial List of Industries for Which Presstite has successfully Developed Special Sealing Compounds:

For the Aircraft Industry:
Sealers for
- Integral Fuel Tanks
- Fuselage Seams
- Drop-off, Expendable Fuel Tanks
- Gun Turrets
- Synthetic Glass
- Instruments
- Intercoolers
- Air Ducts
- Insulating Dissimilar Metals
- Seaplane Floats

For the Refrigeration Industry:
Sealers for Domestic and Commercial Refrigerators
Bonding and Sealing Low Temperature Insulation in Refrigerated Rooms

or the Railroads:
Sealers for Insulating, Soundproofing and Weatherproofing of Railway Cars—Sealing Car Windows and Spot Welded Seams

For the Building Industry:
Roof Coatings, Caulking, and Waterproofing Compounds

For the Shipbuilding Industry:
Insulation Adhesive and Sealers — Rust Preventive Compounds

For the Automotive Industry:
Special Adhesives and Sealers

For the Construction Industry:
Sealers for Jointing Sewer Pipes
Sealers for Waterproofing Excavation Work

Miscellaneous:
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Plus Many Special Products for the Army and Navy

Our Engineering, Technical, and Laboratory facilities are at the service of any industry with a sealing problem

THIS ADVERTISEMENT COULD BE WRITTEN ONLY ABOUT

U·S·S STAINLESS STEEL

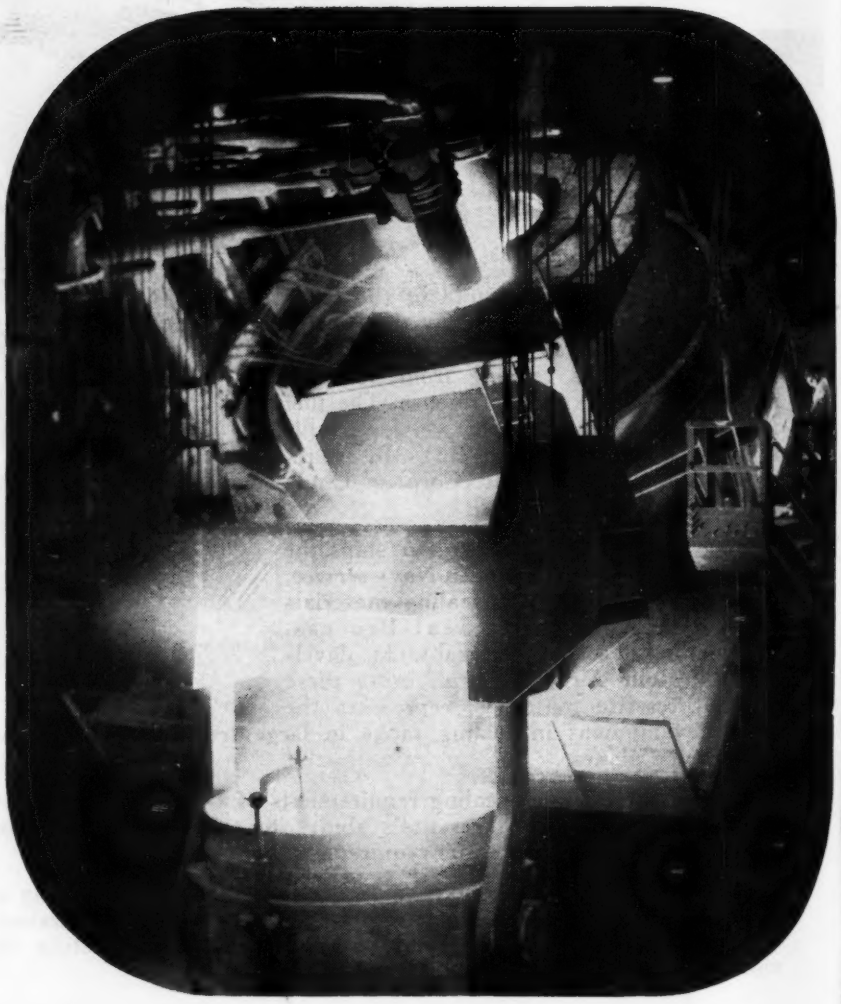
No member of the U·S·S family of steels has been more highly favored than U·S·S STAINLESS. From its very beginning, highly specialized staffs have constantly perfected its characteristics, improved its performance and widened the scope of its applications.

Definitely a specialty product, U·S·S Stainless is made in plants particularly adapted for its manufacture, and is handled throughout by specially trained personnel. The equipment and facilities devoted to its exclusive manufacture are the last word in completeness and modern design.

However, this is not the complete story. For U·S·S Stainless is not confined to nor limited by the facilities or research staff of a single plant, division or company. It has at its beck and call the enormous plant facilities, the wide selections of rolls and the huge research organization of the entire United States Steel Corporation.

Because of this, U·S·S Steel produces the widest range of stainless shapes and sizes in the world—bars, sheets, plates, strip, pipe, tubing, wire and special sections—in all standard grades and specifications.

In addition, the services of the industry's largest staff of steel technicians are available to help you solve any problems involving the use of U·S·S Stainless Steel.



U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
United States Steel Supply Company, Chicago, *Warehouse Distributors*
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USS STEEL — UNITED STATES STEEL

Buy more War Bonds!

Service record lost— but service record made!

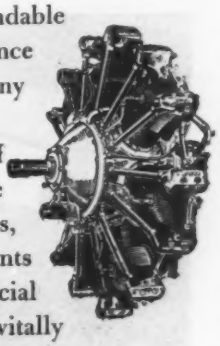
In one of the Allied Air Forces, a group of planes powered by Jacobs was transferred to a distant field . . . and somehow, the service record of one Jacobs engine was mislaid.

It turned up some months later, as service records have a habit of doing. And the engineer in charge of engines was horrified to learn that the engine with the retarded service record had rolled up *more than 1,900 flight hours!*

The plane was grounded at once. The mechs took out the engine tenderly, as if it might fall apart at any instant. The overhaul showed that it had worn piston rings, a noisy rocker arm, needed some new gaskets—and that's all!

WHEN the war started, the Jacobs was rated at 350 hours between major overhauls. The period was gradually extended as high as 1200 hours. Now, nobody knows how long a Jacobs engine will deliver before it needs an overhaul.

Military operation demands high efficiency, regardless of cost. The Jacobs engines in the training program take more take-offs and more time at full throttle, get more sustained wear, than any engines used in combat service—or commercial service! Yet deliver dependable power, with low fuel and maintenance costs that would mean a profit in many types of commercial operation!



Largest maker of plane engines of medium power rating, Jacobs will have postwar models suited to light planes, and up to medium transport requirements . . . Plane manufacturers and commercial operators may find the Jacobs line a vitally important item in future operation programs . . . Inquiries are invited . . . Jacobs Aircraft Engine Company, Pottstown, Pennsylvania.

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Photo-reproductions FROM YOUR *BLUEPRINT MACHINE!

Peerless Photo-Arc reproduction papers can be printed in any kind of continuous blueprint machine. They can be handled in a normally lighted room.

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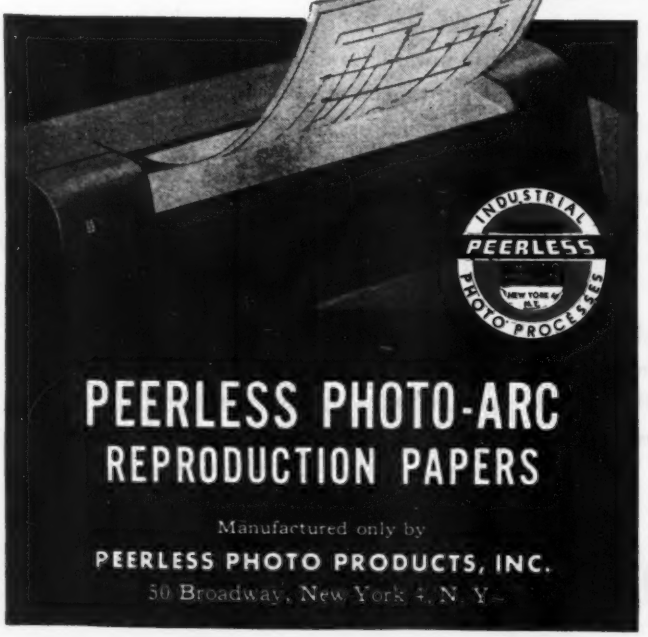
For full information write for Bulletin 1-b



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Callite Fine Wires

THE USES, present and potential, of Callite fine alloy wires are infinite. For example: consider the possibilities for aviation devices. Callite draws wires for instrument shafts and parts with high precision that makes possible smooth *drawn* surfaces instead of machined surfaces.

CALLITE WIRE for control cables in instrument and radio controls give the desired strength and flexibility. Callite wires can be used for springs, screen cloth, leads, wire forms, etc. In other words, Callite fine alloy wires are custom-built to suit the application.

Other Callite special wires and "Clad" wires (bi-metal combinations) open new vistas to designers. Investigate our wide range of wire products for all purposes. Take advantage of our engineers' specialized knowledge and long, varied experience. Consult us on specific applications.

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KULGRID AND OTHER "CLAD" WIRES

Fine alloy wires in aluminum, phosphor-bronze, everdur, stainless steel, silver, silicon bronze, brasses, and special alloys. Precision diameters down to .002", or smaller. On spools, coils or cut to your exact specifications.

Special Whiting engine stands facilitate the assembly of these 2,200-horsepower power plants for Boeing Superforts.

Building a Power Plant for a Boeing B-29

Huge Whiting engine stands help build Superforts

A typical application of Whiting's sixty years of experience in the building of special equipment, these lines of Whiting engine stands speed assembly of powerful motors for Boeing Superforts.

In engine assembly and many other phases of the aircraft industry, Whiting Collateral Engineering Service offers skilled assistance. Collaborating with operator and manufacturer, Whiting engineers develop equipment to solve the handling, loading, and maintenance problems created by today's larger and faster planes.

Heavily armed and with a wing-spread of over 141 feet, the Boeing B-29 Superfortress is one of our most formidable weapons.

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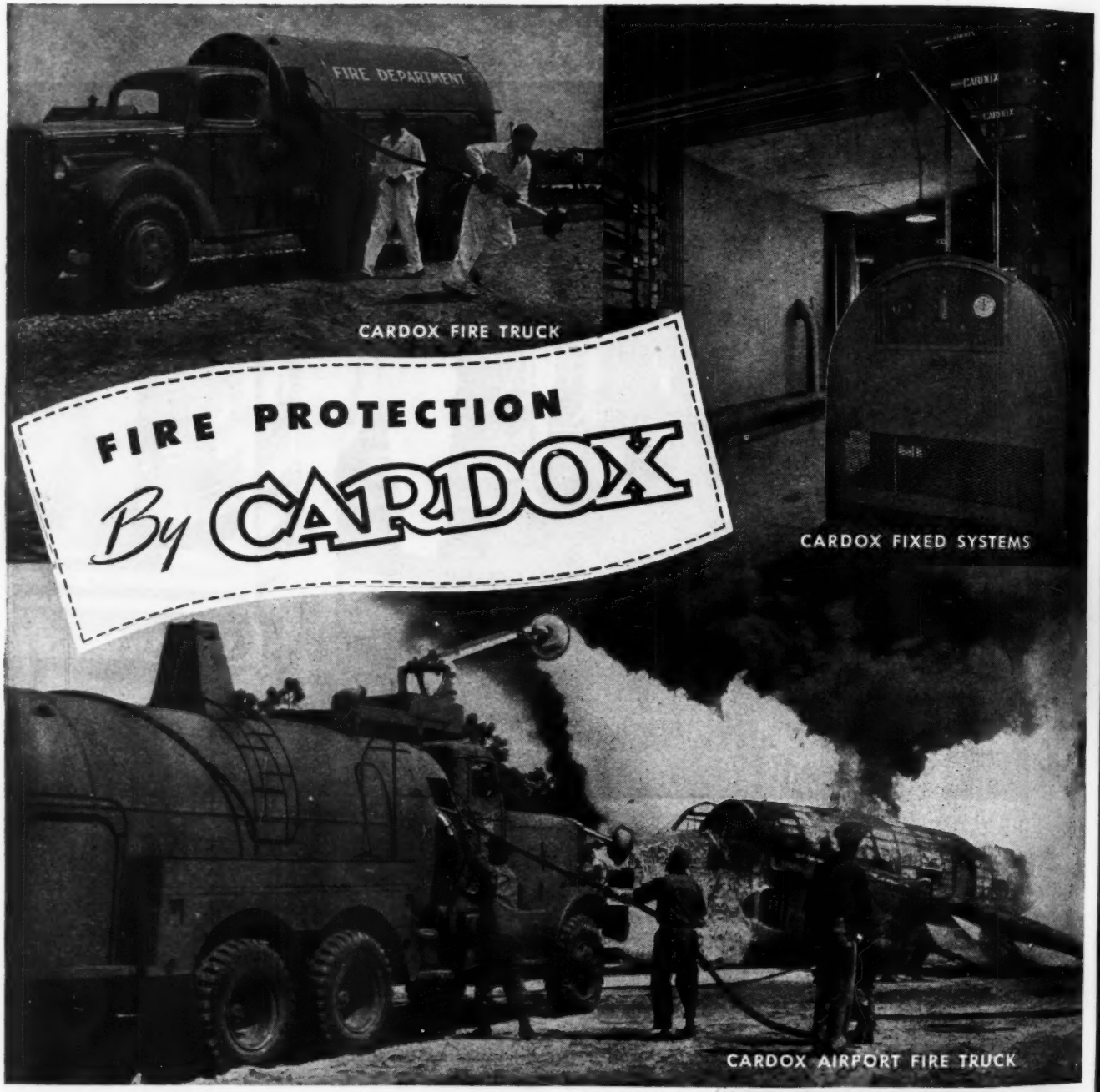
MATCHED HANDLING AND MAINTENANCE EQUIPMENT



In and around America's vital war plants . . . on our big and busy military airfields . . . fire protection is provided by Cardox Fire Extinguishing Systems, Fire Trucks and Airport Fire Trucks.

Each is a highly specialized fire extinguishing tool . . . exactingly engineered to do a specific job quicker and more effectively than it has been done before. But all Cardox Systems and Mobile Units have one outstanding characteristic in common: *Cardox Engineering in the application and control of carbon dioxide, stored at 0° F. and 300 p.s.i. in a single Storage Unit containing from ¼ to 125 tons of fire-destroying Cardox CO_2.*

For Cardox has given the recognized advantages of carbon dioxide a new and broader scope of fire extinguishing performance. Because of this, these advantages can be applied equally well to small or *very large* fires through *mass* application of Cardox CO_2, released in *pounds* or *tons*.

The efficiency of Cardox Systems and Mobile Units in giving fast-acting, nondamaging carbon dioxide *enhanced extinguishing* performance is made possible by Cardox methods of control and application that give Cardox CO_2: (1) Uniform extinguishing characteristics regardless of plant or atmospheric temperatures; (2) Availability in ample quantity for uninterrupted protection and mass application at high rate; (3) High CO_2 "snow" yield for increased cooling effect; (4) Effective projection through relatively great distances.

On the basis of this performance Cardox has been given many of the toughest fire protection assignments—*all over the country*. Find out how through practical cooperation Cardox and its engineering staff can assist you to make your planned fire protection more effective. Write on company letterhead for Bulletin 0011.

CARDOX CORPORATION
BELL BUILDING • CHICAGO 1, ILLINOIS

District Offices in New York • Boston • Washington
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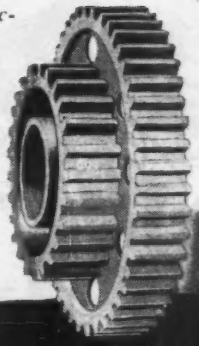
CARDOX
CO_2 FIRE-EXTINGUISHING SYSTEMS

Gears as large as this giant or as small as you wish—produced individually or on a production basis.

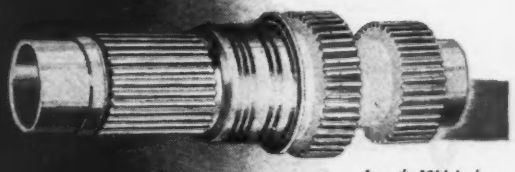
Diameter: 17½ Feet



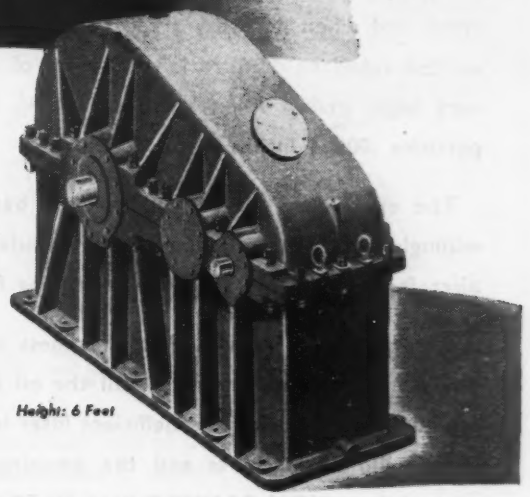
Diameter: 5 Inches

"Aircraft Quality" Gears can give you higher speeds, lighter weight, less noise and greater efficiency.

FOR BETTER POWER TRANSMISSION CALL FOOTE BROS.



Length: 10½ Inches



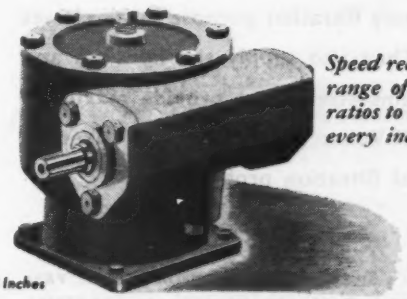
Height: 6 Feet

You may require a giant spur gear to turn a cement kiln. Your production may demand gears of aircraft quality produced by the thousands. You may operate a paper mill—a steel mill—a chemical plant—where your needs for speed reducers vary from midgets, so small you can lift them with one hand, to giants weighing tons. Or, perhaps, you build aircraft engines where advances in gear engineering and newly developed production techniques have made possible the mass manufacture of gears that closely approach engineering perfection.

No matter what application for power transmission equipment you may have—Foote Bros. can aid you.

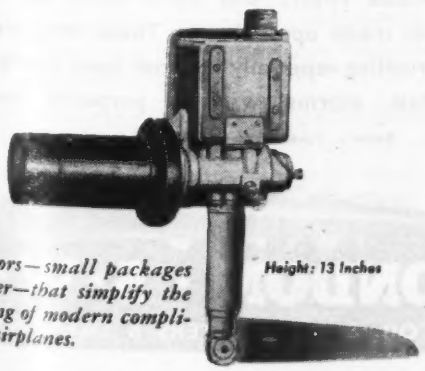
Why not let the years of experience—the vast production facilities—the manufacturing "know-how" of one of America's largest and oldest makers of gears help you solve your power transmission problem?

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. G, 5225 S. Western Boulevard • Chicago 9, Illinois



Speed reducers in a wide range of sizes and gear ratios to meet practically every industrial need.

Height: 5 Inches



Actuators—small packages of power—that simplify the handling of modern complicated airplanes.

Height: 13 Inches

FOOTE BROS.

Better Power Transmission Through Better Gears

PIONEERS ...

VOKES pioneered efficient filtration against years of indifference, war conditions however have proved that our ideas and designs were right, and when necessity arose we had the filters available. Vokes have set the standard of filtration efficiency of their Air, Oil and Fuel Filters very high, giving when required 99.9% filtration of all impurities to particles .00004 inches in diameter.

The experience gained under actual battle service conditions will be willingly passed to designers and manufacturers of Aero engines and aircraft for help and guidance in solving filtration problems.

Experience has proved that cheapness does not pay. You must have filters that filter all the air or all the oil all the time. This Vokes Filters are guaranteed to do. An inefficient filter is dangerous to the life of machines and the amazing men who control them. **YOU CANNOT BUY FILTRATION ON PRICE.** Vokes have produced over 3,000 different models of their various filters and can supply any type of filter for every filtration purpose in all classes of industry. They also supply the housings and inducting systems essential to provide maximum efficiency of all Vokes Filters. Consult Vokes on all your special filtration problems.

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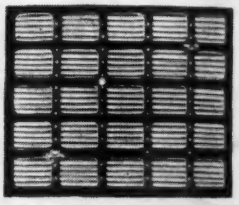
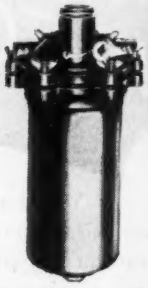
VOKES FILTRATION & SILENCING CO. INCORPORATED, 101, PARK AVENUE, NEW YORK & VOKES (CANADA) LTD., 1123, BAY STREET, TORONTO, CANADA.

CONTRACTORS TO BRITISH AND DOMINION GOVERNMENTS.

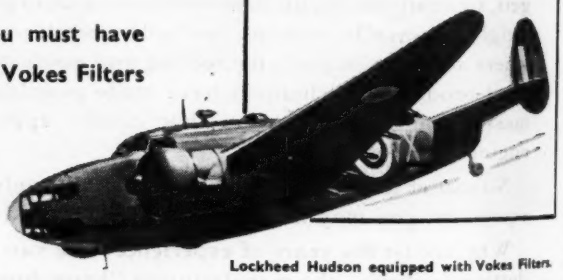
Vokes Oil Filter for Aircraft



Vokes Aerovee Filter Element.



Vokes Oil Filter, Test-bed type



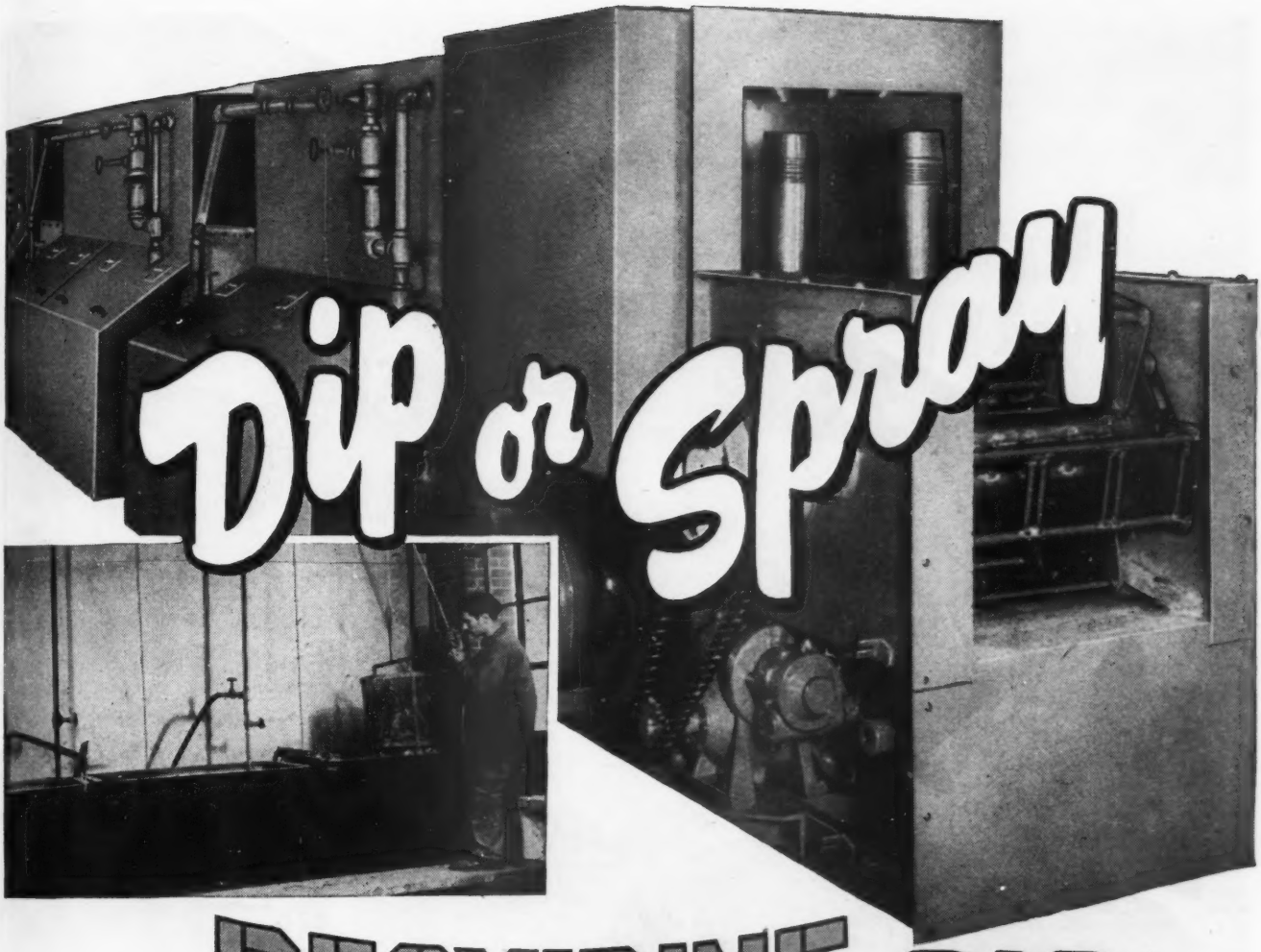
Lockheed Hudson equipped with Vokes Filters.

Fighters, bombers and reconnaissance machines of British, American and Allied Air Forces operating in all battle areas have been fitted with Vokes Filters and have stood up to all demands made upon them. These demands have been gruelling especially in those cases where sand and dust storms were a perpetual menace.

Below: Vokes Flametrap Silencer for aircraft.

VOKES · LIMITED · LONDON · S·W·

DESIGNERS, PATENTEES & MANUFACTURERS OF AIR, OIL & FUEL FILTERS & SILENCERS



with DEOXIDINE 210 to meet Ordnance Specifications

Cleaning and Conditioning Ferrous Metals with **DEOXIDINE 210** meets Army Specifications AXS-1245 Finish when used as directed in ACP Technical Data Sheets No. 3-2-210-2 and No. 3-2-210-4.

This phosphatic cleaning material quickly removes cutting oils and soil and at the same time properly conditions the surface of the many ordnance parts for paint finish. A three-stage (spray or dip) washer is all that is required to perform simultaneously both cleaning and conditioning operations. Mild steel equipment, throughout, is satisfactory — stainless steel may be used but is not required. **DEOXIDINE 210** is a superior cleaner meeting wartime requirements today, and will be equally valuable in peacetime production.

The detergent properties of **DEOXIDINE 210** are excellent and, being acidic, eliminate the danger of leaving paint removing or paint bond destroying alkali residue on the cleaned metal surface.

There are other types of DEOXIDINE suited to varying requirements in metal cleaning and for application by spray, dip or brush.

The experience of ACP Technicians is at your service to recommend the DEOXIDINE and method of application best suited to your needs.

Manufacturers of Inhibitors & Metal Working Chemicals

AMERICAN CHEMICAL PAINT CO.
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CHEMICALS ACP PROCESSES

American Chemical Paint Company, Ambler, Pa.
Please send me general Technical Service Data Sheets on
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*Name*_____ *Title*_____

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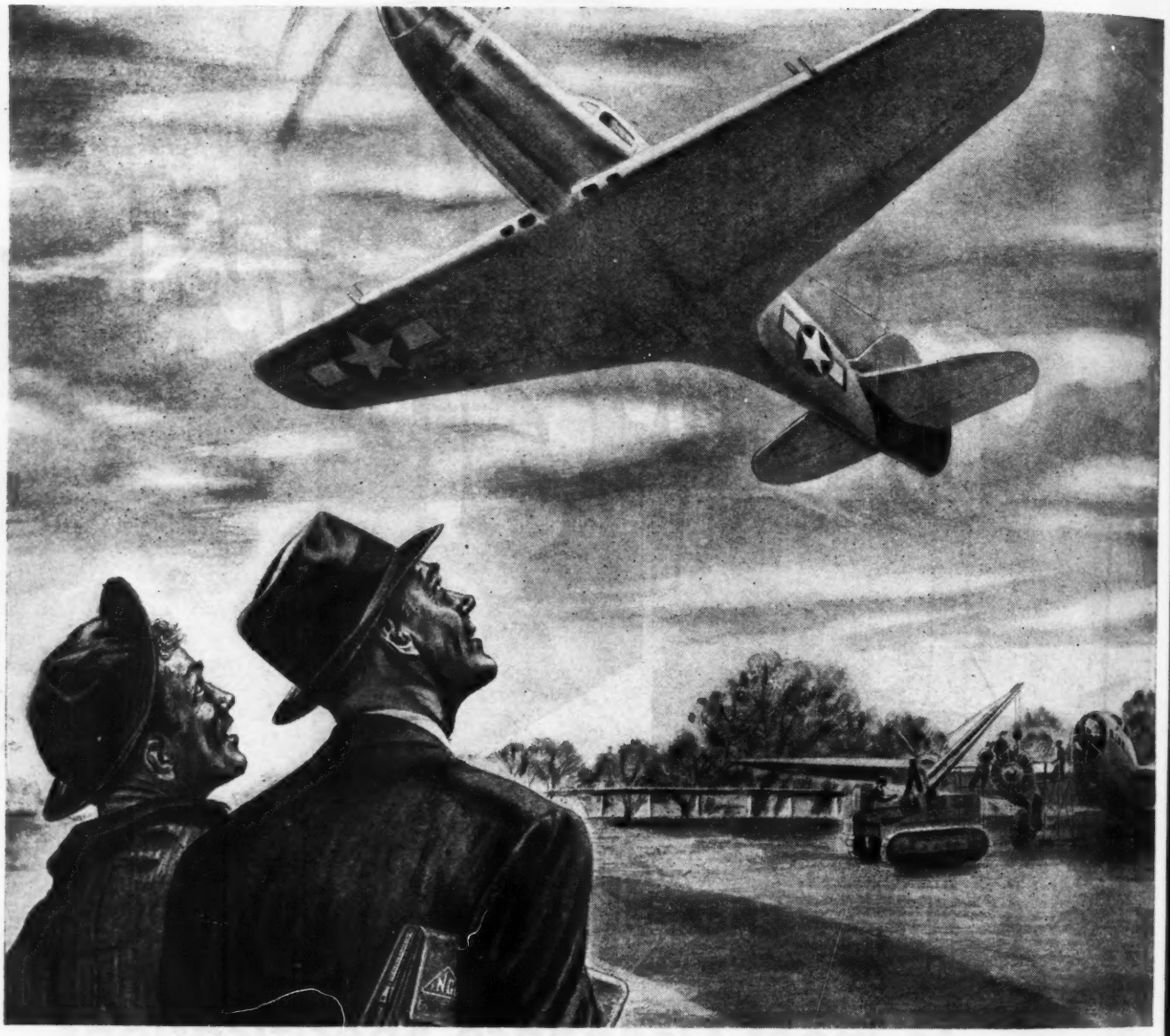
J-1



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The design engineers of the aeronautical industry have repeatedly met demands for improved aircraft to serve on world-wide fighting fronts. At the same time the industry has been able to turn out huge quantities of highly complex precision mechanisms on a mass-production basis.

Since the pioneer days of the aviation industry, it has made extensive use of materials containing Nickel for engine and fuselage parts. In these applications the industry's engineers have developed to the fullest extent the useful and unique properties contributed by Nickel to the materials commonly used in aircraft construction.

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. . . and ~~never~~ the twain shall meet

"East is east and west is west," wrote the poet, "and never the twain shall meet."

But he was wrong.

The twain *shall* meet. The peoples of the earth shall begin to know each other — and work together — for peace and plenty for all.

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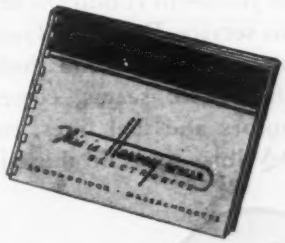

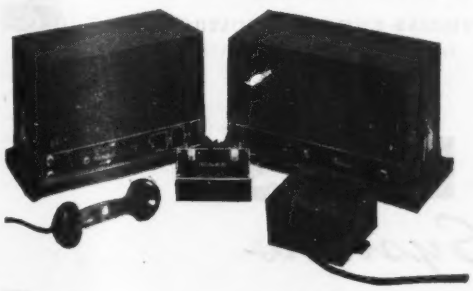

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uses DeVilbiss Equipment
to surface recondition their huge seaplanes

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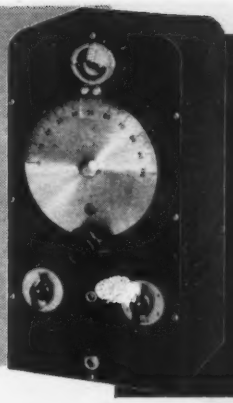
You Are Going to Want BROWNING FREQUENCY METERS



How will you have them?

Take this opportunity to name your specific desires . . . to have your own wishes incorporated into equipment you will want to make standard for mobile radio installations.

You will want Browning Frequency Meters because they do what you will want them to do, at a price that will let you use them generously.

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- Check, with better than .005% accuracy, any five frequencies from 1.5 to 120 Mc.
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- Cathode ray indicator permits visual check against crystal standard and transmitter.
- Complete voltage stabilization.
- Portable, light-weight, A.C.-D.C. operation.

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Certain interesting improvements are already in store for this product of Browning Laboratories research. Whole-hearted devotion of all our energies to war production keeps them in the planning stage. But our postwar thinking, as it takes shape in rough sketches, turns to you — the future owner of future Browning Frequency Meters. We want you to have what you want.

Your letter about what you want in Browning Frequency Meters will receive a cordial welcome. And will, if possible, be reflected in the model delivered to you when we can deliver. Write soon, won't you?

BROWNING
LABORATORIES, INCORPORATED
WINCHESTER, MASSACHUSETTS

Browning Laboratories, Inc.
750 Main Street
Winchester, Mass.

Gentlemen:

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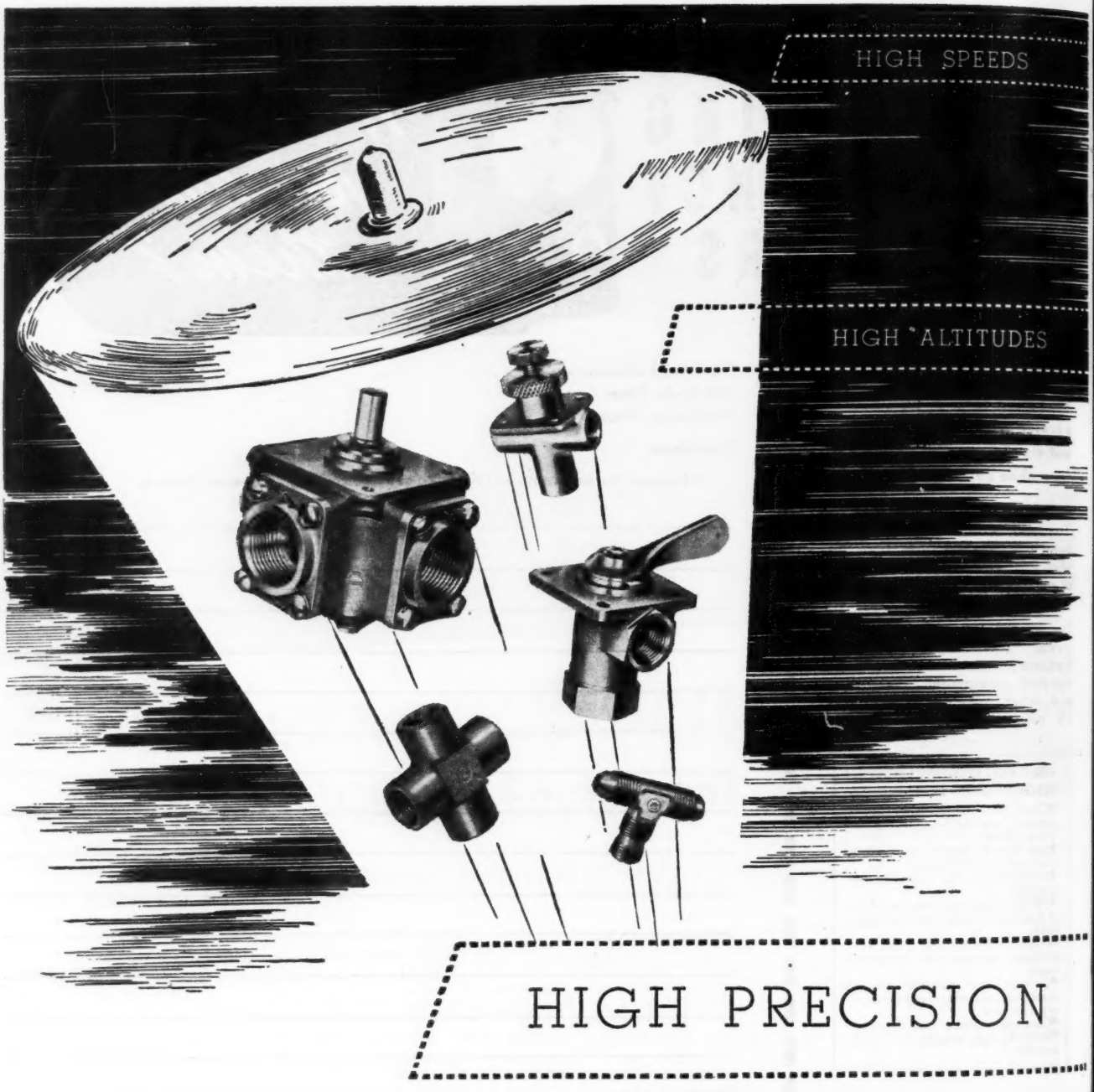
HERE ARE MY ROUGH SKETCHES



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Reg. U. S. Pat. Office

offers something NEW in a strong, lightweight material which can be easily produced to your requirements

The strength characteristics of PLYTUBE* are the result of a method of laminating the veneers and bonding glue, rather than the kinds of wood and glue used. Results of laboratory tests on small diameter tubing disclose the following average strength characteristics of PLYTUBE per sq. in.:

Ultimate Compressive Strength	11,500
Ultimate Tensile Strength	11,000
Compressive Proportionality Limit	6,000
Tensional Proportionality Limit	6,000
Deflection, Young's modulus	1,500,000
Axial Expansion, Young's modulus	1,700,000
Buckling Failure, Young's modulus, Euler's formula	11,000
Specific Weight (approx.)	0.75

PLYTUBE has already been put to valuable, effective use. Applications thus far made predict fields of utility in which its great strength and light weight can be taken advantage of in improving product design, construction and manufacture. Fabrication is simple and economical. Handling is greatly facilitated because of its form and lightness in weight.

All the advantages of PLYTUBE as a material of construction can be made available in countless ways in an almost unlimited variety of products. These advantages are of such importance as to command your careful investigation. A study of the possibilities of PLYTUBE *now* will open up applications for its use that can well revolutionize your future manufacturing plans. Our engineers are prepared to work with you on your ideas and apply our research facilities in developing whatever uses you consider advantageous. Ask for further data on PLYTUBE, using coupon below. Samples will be sent on request.

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Characteristics:

High Mechanical Strength
Corrosion Resistance
High Dielectric Strength
Wide Variety of Sizes
Easy Workability
Low Costs

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AV. 1-45

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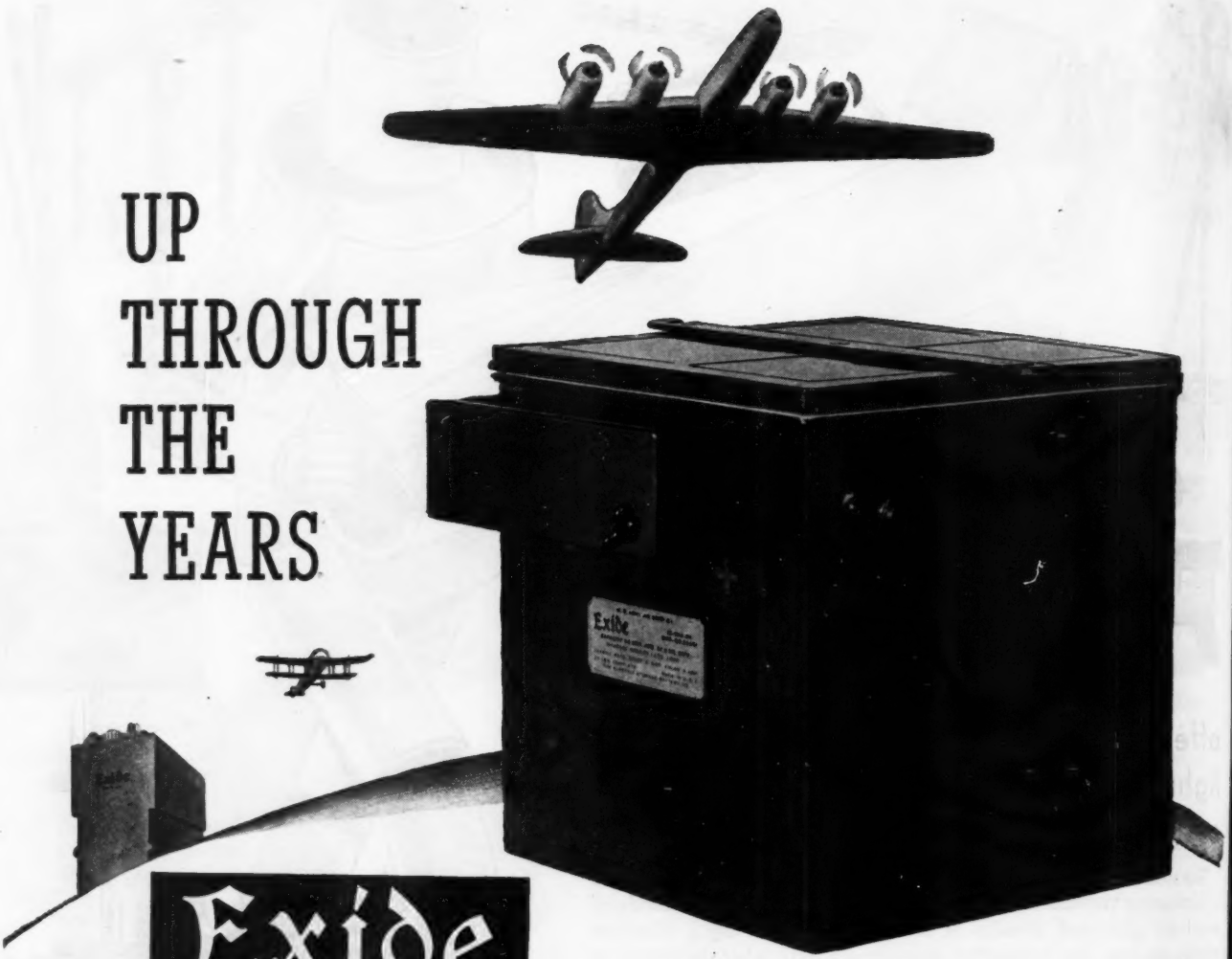
UP THROUGH THE YEARS



Exide
AIRCRAFT BATTERIES

have kept pace with Aviation's increasing needs

From the time when Exide Batteries first took to the air in 1917, they have traveled astronomical distances and seen aviation history in the making. Exide Batteries were on pioneering air voyages over the Atlantic and Pacific Oceans, over the North and South Poles, around the world and on many other important flights. And in the meantime they have traveled millions of miles in U.S. Mail and commercial transport service.

As aviation engineering advanced, Exide engineering kept pace. When each newer and bigger plane was placed in service, there were Exide Batteries ready to meet the plane's greater needs. Today, while aviation history is adding new chapters to its amazing story, Exides are serving on America's flying craft throughout the world. And they are performing their numerous tasks with dependability, long-life and ease of maintenance.

A LETTER FROM THE SOUTH SEAS

Interesting letters are received from many of the more than 1400 Exiders now in the Service. This one comes from New Guinea:

"I'm now overseas and am stationed somewhere in New Guinea. Uncle Sam has plenty of equipment down here that is powered by our Exide Batteries. That black box with the orange paint sure brings back some swell times."

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32
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"FROM COTTON TO CUTTER"

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**Residual shrinkage less than 1%*

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says this Department Superintendent

Actual photo of a Gulf Service Engineer (left) consulting with Department Superintendent of American Manufacturing Company, Fort Worth, Texas, on the machining of shell adapter rings.

WE HAD EXCESSIVE REJECTS of shell adapter rings when we used soluble oil as the cutting fluid. In addition, main bearing trouble developed in the machine. So we tried Gulf Lasupar Oil and Gulf Cut-Aid, as recommended by the Gulf Service Engineer," says this Department Superintendent. "Now we have a very low percentage of rejects, no bearing trouble, and get much longer tool life."

Again and again, on the most exacting war assignments, Gulf Cutting Oils have made outstanding improvements in production and tool life. Here's the important reason: Every Gulf Cutting Oil has specific properties which insure better performance on certain types of machining jobs!

It will pay every machine shop to learn the full possibilities of Gulf's production-proven cutting oils. Call in a Gulf Service Engineer today and let him show you how they can help you with your machining problems. Write, wire, or phone your nearest Gulf office.

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A bearing that assures a smoothly functioning crankshaft on a modern airplane engine *must* have certain advantages. It must have high load capacity to take cylinder impulses. It must run almost effortlessly under high speeds. A one-piece retainer permits ease of disassembly and a thorough inspection of all parts. All of which describes this SKF Cylindrical Roller Bearing—pioneered and developed by SKF in cooperation with engine designers.

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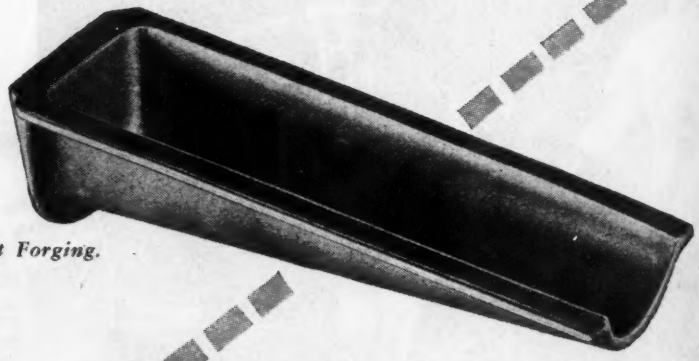
SKF

ball and roller bearings

an aircraft . . .
FORGING



Socket Forging.

Reference Data Booklet presents many new ideas on forgings and their applications in many different kinds of equipment. Copies available to engineers, metallurgists and executives.

Unprecedented demands for forgings have been met. Success has crowned efforts to forge many so-called "impossible-to-forge" aircraft parts. Ideas and experience gained from utilizing over and over again all the known forging techniques for the IMPROVEMENT OF METALS BY FORGING have been a vital element in assuring dependable performance of all types of aircraft. Consult one of our forging engineers about your forging requirements. He represents 31 years of venturesome forging production effort.

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It was the first great airline to recognize the superiorities of Collins design, workmanship, and performance, the first to avail itself of the precise, sturdy, reliable Collins Autotune.*

Today Braniff uses Collins multi-channel or Autotune equipment at every point at which it has a radio station, and every ship in its *Super* B *Liner* fleet carries a Collins 17F Autotune aircraft transmitter.

There is a deep satisfaction in having supplied the nerve-system on which Braniff relies in maintaining its magnificent record of safety and operating efficiency.

When Collins turned to war production, it could apply the know-how that came from furnishing communication equipment which met the exacting needs of Braniff and other major airlines. When it returns to civilian design and production, it will add to that know-how the tremendously increased, intensified experience acquired in its services to the Armed Forces. Collins Radio Company, Cedar Rapids, Iowa.

ARMY E NAVY

*The Collins Autotune is a repositioning mechanism which quick-shifts all transmitter or receiver tuning controls simultaneously and with extreme precision to any one of a number of pre-determined frequencies. Patents issued and pending in the USA and other countries.

COLLINS

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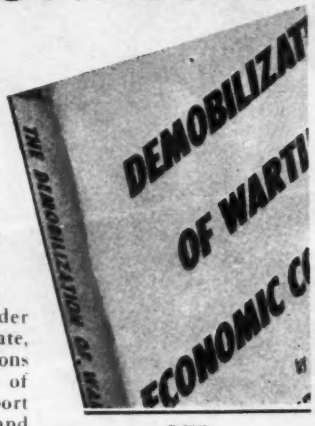
How to relax wartime economic CONTROLS safely—

in line with postwar job objectives

This book deals fully, clearly, and readably with the vital and many-sided question of demobilizing wartime controls. It presents a thorough survey of the kinds of controls, their objectives, authority, effect, etc., analyzes carefully the varying circumstances under which need for them may abate, and offers specific recommendations for the time, manner and degree of their cessation that most will support objectives of high production and job opportunities in the postwar period.



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Fulmer ★ Aircraft Rod Borer

IS designed for *precision* boring of all types of aircraft connecting or articulating rods. Holes bored by this machine are round, straight and parallel. They have a mirror-like smoothness—no hand fitting is required.

Portable and simple to operate, the Fulmer Aircraft Rod Borer is easily set up for any size rod in common use. Flexible—will handle crank pin, piston pin or knuckle pin bores.

Holding fixtures are supplied to handle any size rod within the capacity of the machine and any conventional yoke or blade rod used in "in line" engines.

It also does facing, chamfering and radiusing of bearings to extremely close limits in size, straightness and parallelism. Ruggedly built to do precision work.

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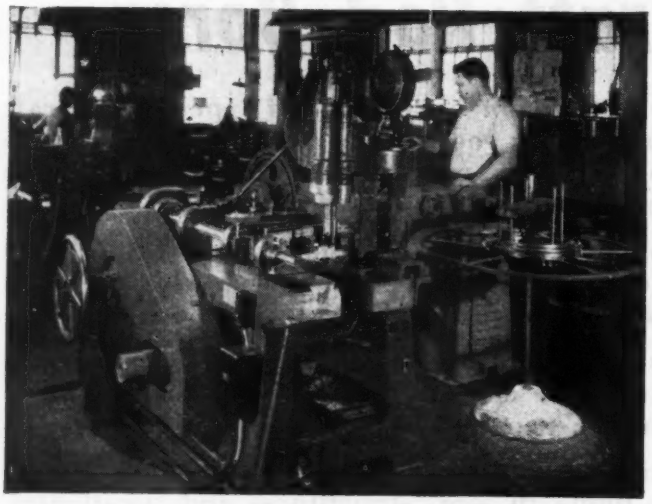

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SEARLE "Press to Test" INDICATOR LIGHT
TRADE MARK REGISTERED

No matter how "day bright" it may be, the ray or beam of a Searle Indicator Light can be instantly detected. This Searle feature of concentrated intensity, in addition to its ray diffusion adjustment for night flying, is positively unmatched in any other light. These superb advantages together with the extra 60° vision feature account for the high preference awarded the Searle light. In addition, unique construction permits use of either screw-base or bayonet type bulbs, both of which are easily and quickly displaced by slight finger-tip pressure, when necessary. This light also may be mounted in panel from front or back. Made in diameters of ⅝". Can replace any ⅝" single hole mounting light. Write or wire for free, full details.

*U. S. PATENTS APPLIED FOR

Searle AERO INDUSTRIES

SEARLE AERO INDUSTRIES, INC. **ORANGE, CALIF.**

Why take a chance on "Locking Open"?

Revolutionary Crown Zipper "two-way" track makes Crown the world's safest, most dependable zipper!

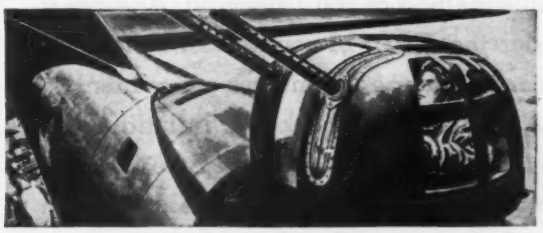
What happens when an ordinary zipper comes open *behind* the slider? Often the zipper must be replaced — and sometimes the article to which it's attached.

But Crown Zippers are different. Even if the teeth *do* come apart behind the slider, there's no harm done. In two quick zips the slider can be moved backward along the track, then forward again, closing the entire track perfectly!

This is made possible by Crown's exclusive tooth construction. Both sides of each individual zipper tooth are identical, making Crown the world's *only* zipper with a smooth "two-way" track! And this is but one of *five* advantages Crown Zippers have over old-style zippers. (See complete listing below.)

That's why you can be sure that Crown Zipper applications in postwar aircraft equipment will give unfailing service—will zip smoother, further, faster, more securely!

Moreover, when you turn to postwar, Crown engineers, fresh from their experience in redesigning hundreds of military items, will adapt—or, if necessary, *create*—special zipper applications to meet special jobs.



Crown's new "double-acting" zipper provides opening wherever needed with smooth closures in both directions.

CROWN ZIPPERS are 5 ways better

1. Takes sharp curves

2. Die-cast for smoother action—extra strength

3. Provides opening wherever you want it

4. Won't lock open

5. Resists corrosion

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We can all see with the naked eye that the Payroll Savings Plan provides the most stable method of war financing. Analyze it under the X-ray of sound economics and other important advantages are evident.

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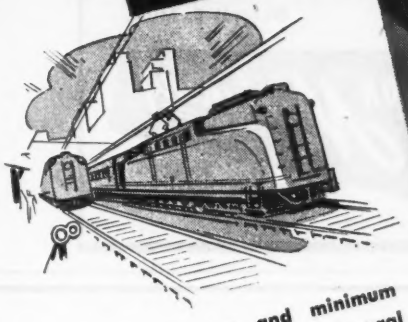

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In compiling this dictionary, the author has endeavored to make it completely inter-American, preference in the choice of words being given to strictly Latin American terms as against Spanish ones. Research included consultations with graduate engineers and mechanics and specialized translators, together with numerous technical books and reviews. The book is helpful in reading technical textbooks, manufacturers' literature, and reports and in translating advertising, catalogs, and manuals as well.

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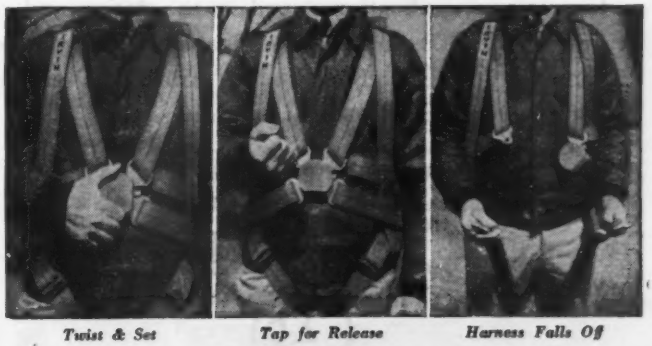

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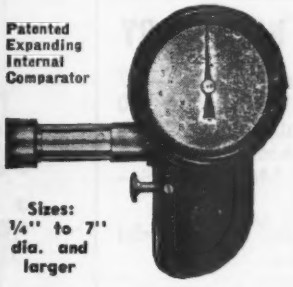

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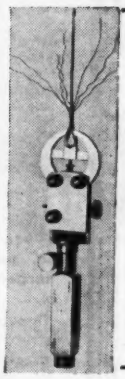

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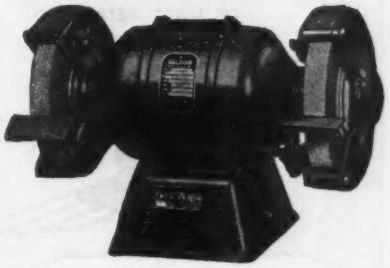

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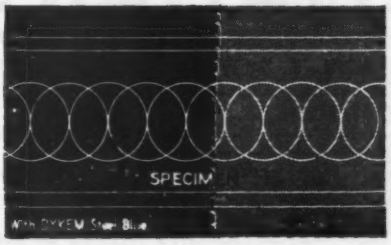

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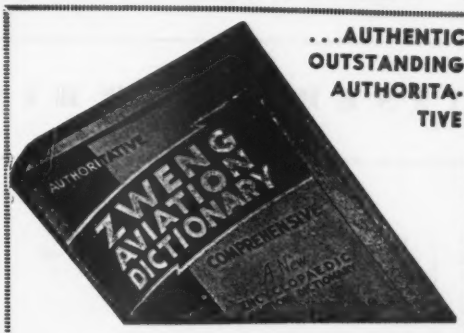

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